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An Analysis of some

TRAVEL TRENDS

between 1956 and 1964

Based on

HOME INTERVIEW SURVEYS

PREPARED FOR THE
METROPOLITAN TORONTO PLANNING BOARD
BY
TRAFFIC RESEARCH CORPORATION LIMITED

Metropolitan Toronto Planning Board
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TRAFFIC RESEARCH CORPORATION LIMITED

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March 31, 1965

Mr. Eli Comay,
Commissioner of Planning
and Secretary Treasurer,
Metropolitan Toronto Planning Board,
790 Bay Street,
TORONTO, Ontario.

Dear Mr. Comay:

We are pleased to submit herewith our report on an analysis of some travel trends between 1956 and 1964 which is based on Home Interview Surveys for the Metropolitan Toronto Corporation Area.

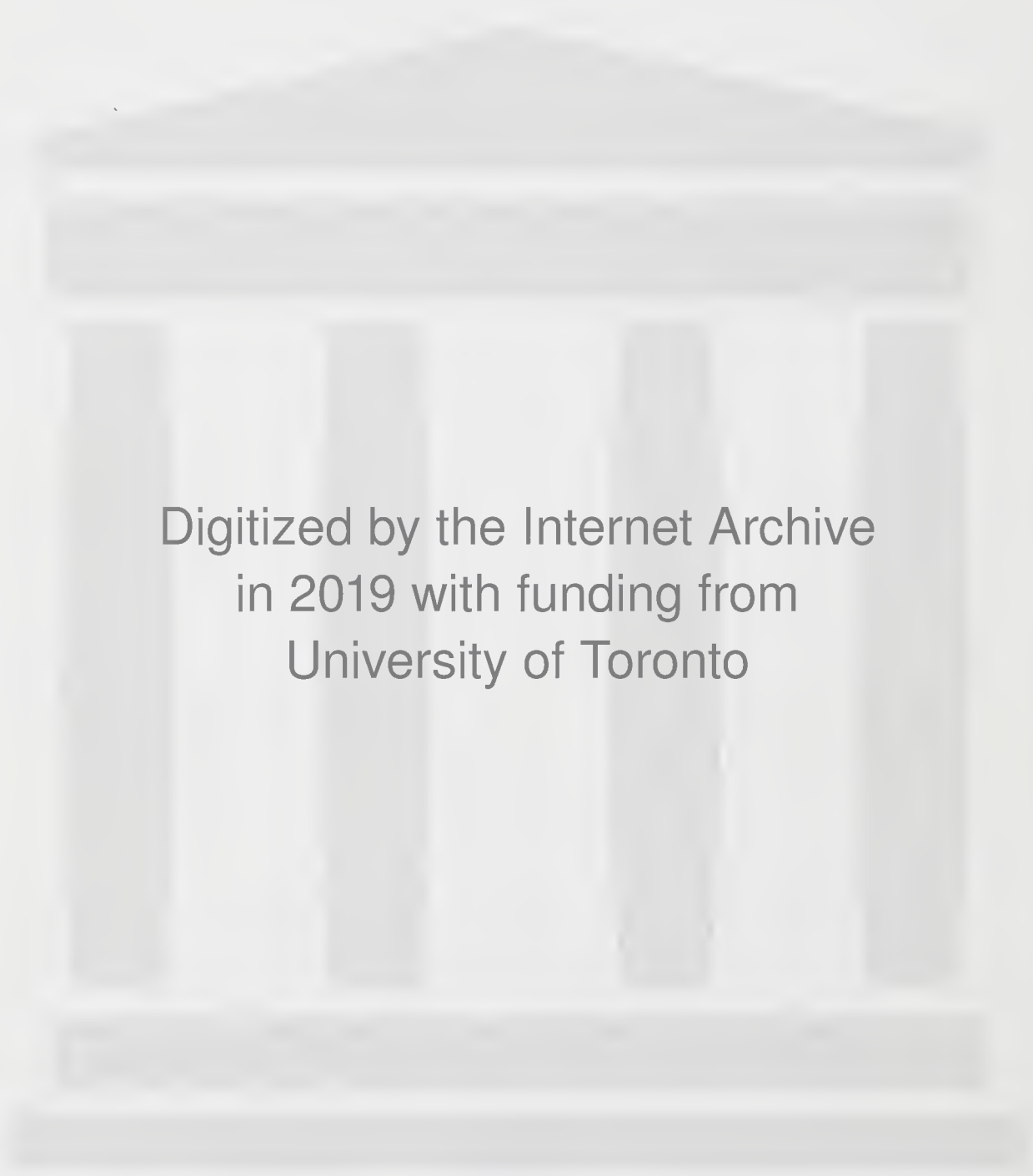
The work carried out during the course of this project was in accordance with the Agreement covering Part I of our Work Program for 1964. In particular, this report describes the collection and analysis of new survey data to re-establish travel relationships and factors affecting travel behaviour and travel patterns. Special emphasis has been directed to reporting the trend analysis which was conducted to establish the change in the public's travel behaviour that occurred between 1956 and 1964.

We are grateful to you, your staff, and to representatives of other cooperating agencies for the help received in carrying out this interesting and importance project. We feel that the results presented in this report represent a significant contribution to the art of travel movement forecasting. This report will serve as a general introduction to a series of Technical Reports which are either completed or will be prepared as part of the continuing research program.

Yours very truly,


H. G. von Cube,
Vice-President.

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Encl.



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METROPOLITAN TORONTO PLANNING BOARD

Travel Trends

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TRAVEL TRENDS
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Based on
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INTRODUCTION

The Home Interview Survey reveals the movement of people associated with the many different population and employment centres in the Metropolitan Area. As might be expected, an analysis of the results shows that travel is orderly and regular. The relationships between this order and the various factors prompting travel assist the planner in assessing present day transportation systems and in evaluating new or improved facilities to meet the needs of tomorrow. In particular it is the purpose of this report to assess and refine the data to be used in the Metropolitan Toronto Planning Board Traffic Prediction Model. For this reason the relationships between travel and the location and size of both population and employment centres will be reduced to a systematic and mathematical statement.

The format is such that the pertinent findings of the survey are described concisely with specific reference to the results of the previous survey carried out in 1956 for comparison. Consideration of this comparison will reveal trends in individual travel over the intervening eight year period. In as much as it is this data which is of greatest significance to the majority of people interested in the traffic survey every effort has been made to present the information here.

The procedure followed in conducting the Home Interview Survey and a statistical analysis of the accuracy of the results are contained in separate chapters of this report. Since the reliability of the results is essential to their application in the planning process these sections are not to be construed as less important but they will be of interest to fewer individuals.

Detailed information on data processing, data sources and data accuracy is contained in the Appendices following the final chapter.



TRAVEL TRENDS

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Close to 2.5 million¹ trips were made by approximately 1.8 million people living in Metropolitan Toronto on an average weekday during the spring of 1964. By comparison less than 1.7 million trips were made by over 1.3 million people in Metropolitan Toronto on a similar average weekday in 1956.² Accordingly, travel throughout the Metropolitan Area has been increasing at the rate of approximately 1400 person trips for every additional 1000 people in the population during the past 8 years.

1. Travel Related to Purpose

The distribution of this travel by major travel purpose is shown in Table 1.1. A direct comparison is made between the surveys of 1964 and 1956.

Table 1.1

Distribution of Travel by Purpose of Travel

Purpose of Travel		1964	1956
1.	Btw Home and Work	49%	50%
2.	Btw Home and Shopping, School, Personal Business	27%	25%
3.	Btw Home and Social and Recreational	13%	12%
TOTAL HOME BASED		89%	87%
4.	Non-Home Based (No end at Home)	11%	13%
TOTAL		100%	100%

1. All statistics reported here apply to travel facts of residents of Metropolitan Toronto so as to permit direct comparison with 1956 travel summaries.
2. Reported in MTPB Report No. 1 "Transportation Research Program", 1962.

It will be noted that travel between home and work (i. e. to and from work) predominates and that 89% of all person trips have their origin or their destination in the home. The survey results suggest little change in the general purpose of travel from 1956 to 1964. The small shift from work travel to travel for other purposes is explained in a refinement of the technique of linking serve passenger trips or change of mode trips to the primary, home-based, leg of the trip³ and is described in Appendix A of this report.

The total amount of travel by each major purpose is shown in Table 1.2.

Table 1.2

Total Person Trips Made on an Average Weekday
by Residents of Metropolitan Toronto

Purpose of Travel		Number of Trips	
		1964	1956
1.	Btw. Home and Work	1,216,000	840,000
2.	Btw. Home and Shopping, School, Personal Business	679,000	425,000
3.	Btw. Home and Social and Recreational	319,000	213,000
4.	Non-Home Based	283,000	199,000
TOTAL		2,497,000	1,677,000

NOTE: There is an increase of 820,000 person trips between 1956 and 1964.

3. For example, if two trips are reported, such as one trip from home to serve a passenger (school child driven to school) and a second trip from serve passenger to work, these would be combined or linked to form a single trip from home to work, etc.

Table 1.3 shows a significant trend in the use of the motor vehicle as opposed to public transportation.

Table 1.3

Percent Motor Vehicular Ridership by Trip Purpose

Major Trip Purpose	Percent Motor Vehicle Ridership	
	1964	1956
1. Btw Home and Work	63%	54%
2. Btw Home and Shopping, School and Personal Business	74%	71%
3. Btw Home and Social and Recreational	84%	74%
TOTAL	72%	60%

It is noteworthy that although little change has occurred in the travel pattern established for shopping and personal business the increased use of the motor vehicle for work and recreational travel has resulted in an overall increase in motor vehicle ridership of 12% since 1956. This increase is probably attributable to the rapid rise in socio-economic conditions and movements of the population to suburban, low-density centres. The total number of person trips is shown in Table 1.4

Approximately 70% of all person trips by private motor vehicles were made as drivers. Thus the average number of persons per car was approximately 1.4 which figure agrees with the average car occupancy of 1.4 in 1956.

Table 1.4

Total Person Trips Made by Motor Vehicles on an Average Weekday
in the Spring of 1964 by Residents of Metropolitan Toronto

Purpose of Trip	Number of Trips	
	1964	1956
1. Btw Home and Work	768,000	454,000
2. Btw Home and Shopping, School and Personal Business	501,000	302,000
3. Btw Home and Social and Recreational	269,000	158,000
TOTAL	1,795,000	1,006,000

2. Travel Related to Time and Space

The great variation in travel observed throughout an average 24 hour weekday follows a regular cyclic pattern. During the peak of the average morning rush hour the amount of travel is 2.5 times the average hourly travel rate. Again in the evening the rush hour rate is 2.7 times the average hourly travel value. The actual number of person trips undertaken in an average 24 hour weekday period is shown in Figure 1.

The purposes for which travel is undertaken readily explain these observations. It is seen that travel to and from work largely accounts for the major portions of the two peak periods. The patterns created by trips for other purposes tend to concentrate in off-peak periods.

The survey results, as shown in Table 2.1, clearly show a directional symmetry for each major purpose of travel. During an average 24 hour period the number of trips destined for any given area equals the number of trips leaving that area.

PEAKING OF TRAVEL WITHIN THE AVERAGE WEEKDAY IN METROPOLITAN TORONTO

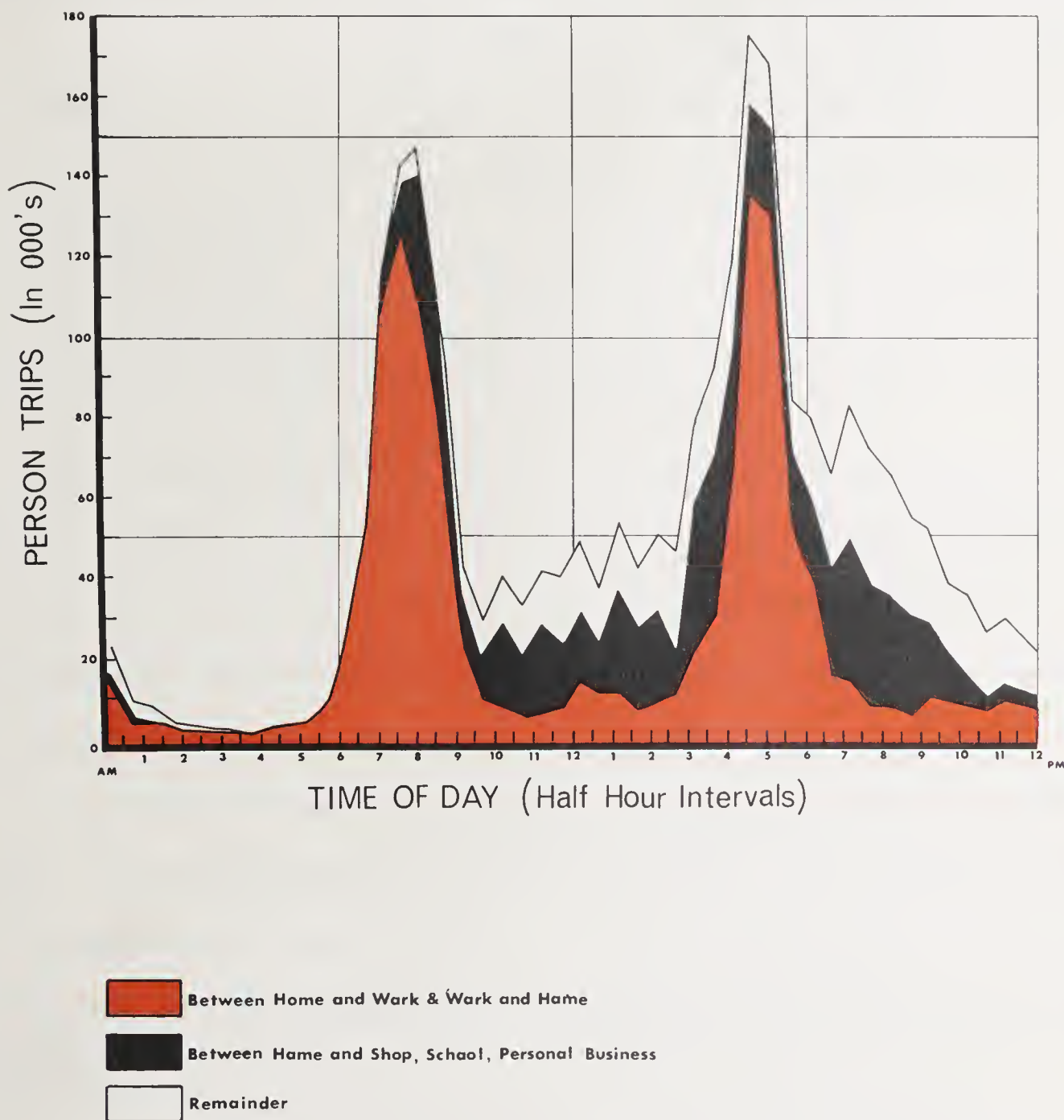


FIG. 1

Table 2.1

Percent Distribution of Total Person Trips by Each Purpose of Travel

FROM		TO			
		Home	Work	Shop Sch. etc.	Social Recrtn.
1.	Home	-	25%(26)*	14%(13)	6% (6)
2.	Work	24%(24)	3% (3)	1% (1)	1% (0)
3.	Shopping, School, Personal Business	13%(12)	1% (3)	3% (3)	1% (1)
4.	Social and Recreational	7% (6)	-	1% (1)	1% (1)

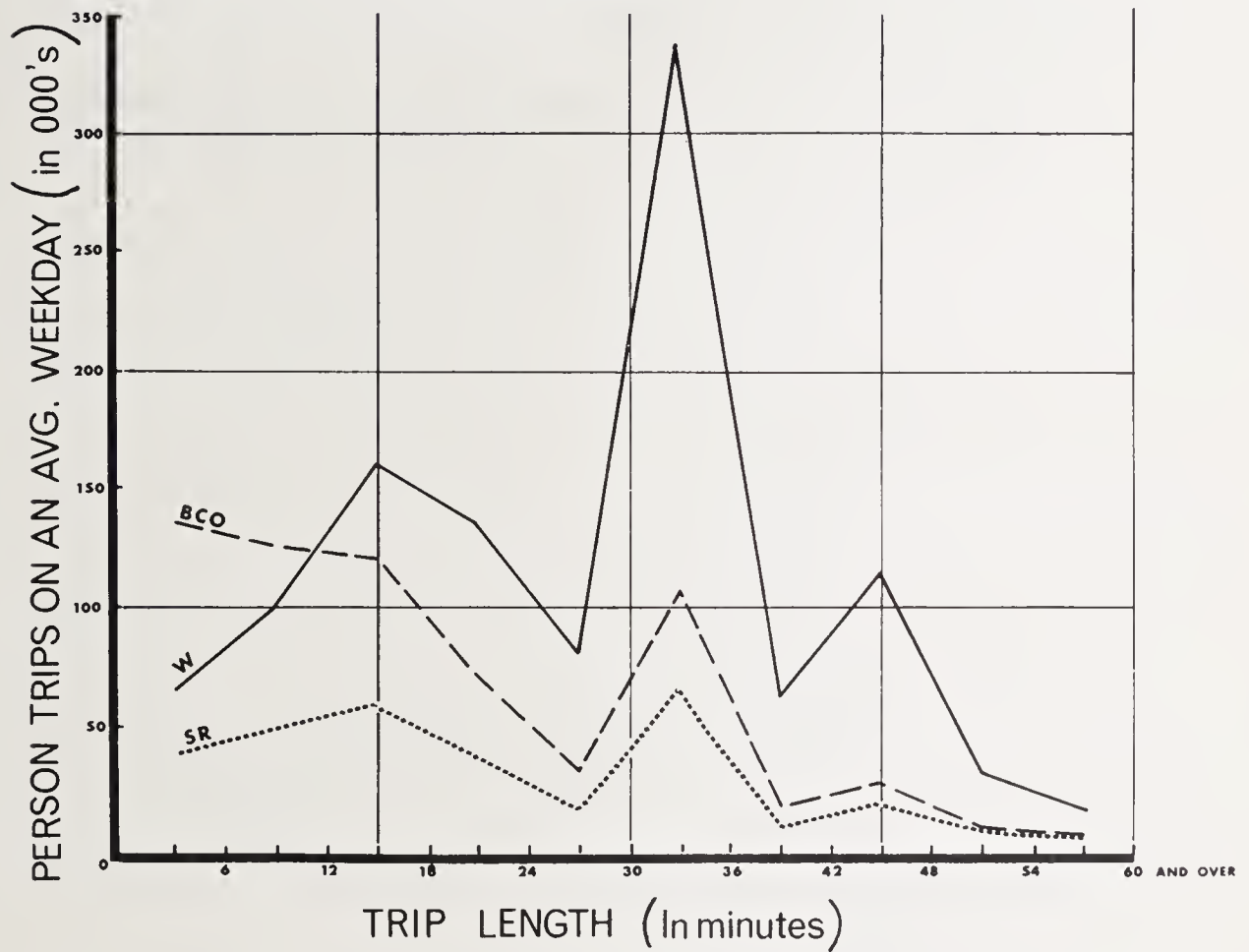
* 1956 Purpose Distribution is shown in brackets (xx).

Again, the importance of the home as either origin or destination is emphasized. Of all person trips, 45% originate at home and 44% are destined to home in the Metropolitan Area. It is recognized that slightly more travel is destined to work than come home directly from work, while more trips return from social and recreational activities to home than go there from home.

The frequency of travel on an average weekday varies with the trip time. Generally, trips of long duration are made infrequently. The relationship between trip frequency and trip duration is shown in Figure 2. Trip frequency generally increases until the average trip length is attained and then declines with increasing trip duration.

The influence of trip purpose can be seen in this relationship. The necessity of travel to work is shown by the fact that longer trips are made more frequently; the average trip time being 30 minutes. Shopping, school and personal business trips as

RELATIONSHIP BETWEEN TRIP FREQUENCY & TRIP LENGTH ACCORDING TO PURPOSE



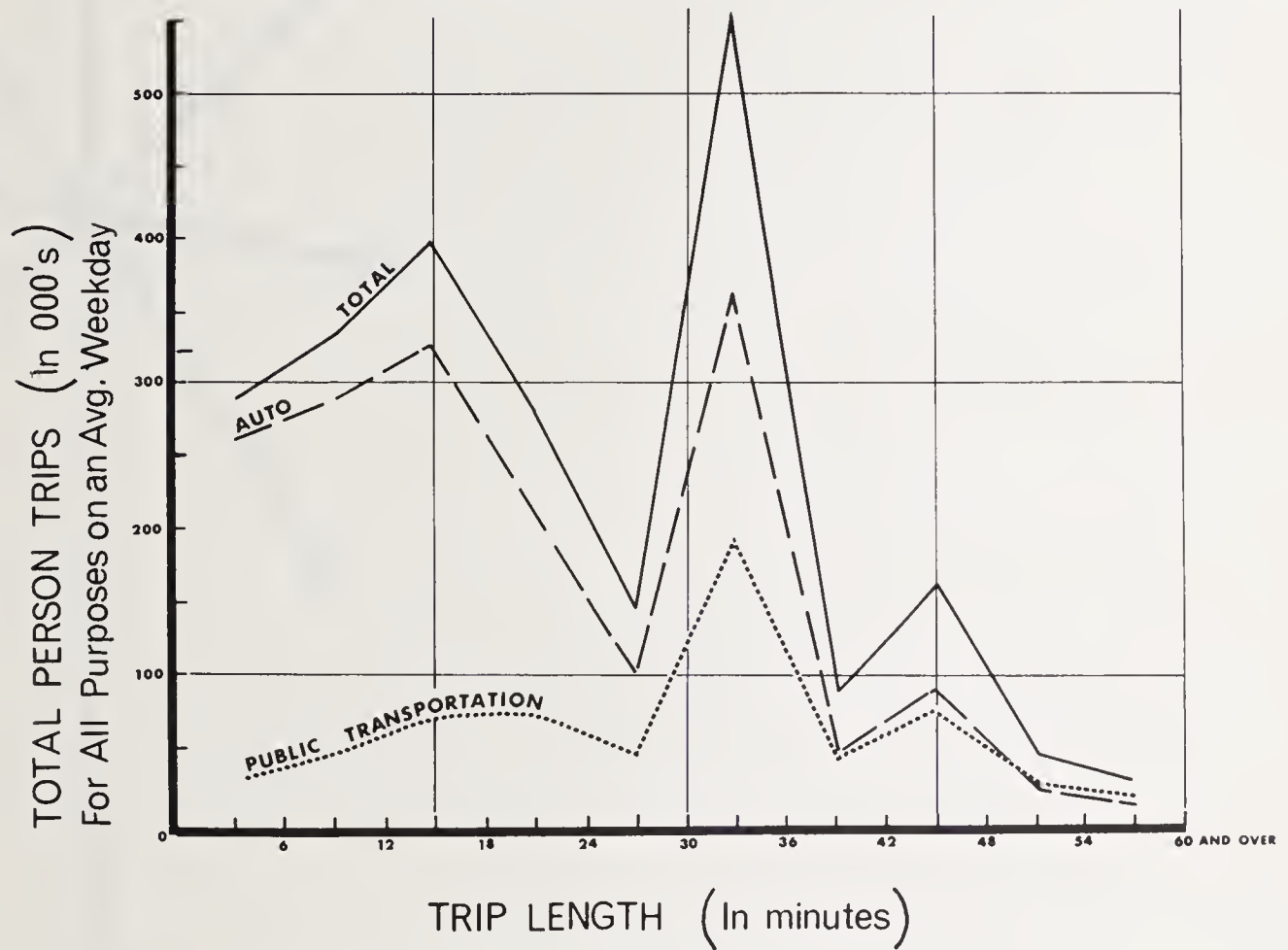
W — Trips between Home and Work
BCO — Trips between Home and Shopping, School, & Personal Business
SR Trips between Home and Social & Recreation

FIG. 2

well as social and recreational trips are of an average duration of approximately 15 minutes.

The method of travel may influence the relationship between trip frequency and trip time. Figure 3 shows the relationship between trip frequency and trip length for total person trips made by each method of travel. The average trip length is 20 minutes for motor vehicle trips and 30 minutes for transit trips to all purposes.

RELATIONSHIP BETWEEN TRIP FREQUENCY & TRIP LENGTH FOR TRAVEL BY EACH MODE .





ANALYSIS TO ESTABLISH

BASIC TRAVEL RELATIONSHIPS

There are five primary travel decisions common to all trips made in the Metropolitan Area.

<div>WHY?</div> <div>Purpose of Trip</div> <div>WHEN?</div> <div>Time of Day Trip Made</div>	Trip Production	<div>ESTABLISHES the amount of total travel during a specified time for a given purpose.</div> <div>VARIES WITH <ul style="list-style-type: none"> - Number of People/Area - People's Characteristics - Number of Work Places - Shopping and Recreational Opportunities </div>
<div>WHERE?</div> <div>Destination</div>	Trip Distribution	<div>ESTABLISHES amount of travel from one are to another</div> <div>VARIES <ul style="list-style-type: none"> (a) Directly with opportunities in each area. (b) Inversely with a function of the travel time between the two areas. </div>
<div>HOW?</div> <div>Method Used</div> <div>ROUTE?</div> <div>Route Followed</div>	Travel Mode Split	<div>ESTABLISHES the diversion of total traffic</div> <div>VARIES WITH <ul style="list-style-type: none"> - Travel Time - Travel Cost - Travel Convenience - Socio-Economic Status - Personal Preference </div>

These travel decisions are inter-related. The assimilation and preliminary analysis of the survey data is described in Appendix A. A series of computer programs was prepared for the 1107 computer to assimilate and summarize the survey data in a form useable for basic travel analysis. The detailed analysis to describe these five basic travel decisions by mathematical relationships is reported below.

1. Trip Production - Why and When People Travel

The 1964 Home Interview Survey provided recent data on the frequency of travel. A summary of this information permitted the establishment of trip production rates for Metropolitan Toronto. The amount of travel generated by each small geographical area (census tract) was related to the number of people, the number of households occupied and the number of cars owned by the resident population surveyed. By a statistical method known as "regression analysis" these relationships were reduced to mathematical equations. Because of their application to traffic simulation programs a consideration of two such equations is made here.

Equation 1:

<div>Total Trips Generated at Home on Average Weekday in 1964 to all Purposes</div>	=	0.318 x Population 5 years and Older
		+
		0.458 x Number of Households
		+
		0.890 x Number of Cars Owned

Equation 2:

Total Trips
Generated at Home during
7 – 9:00 AM
on Average Weekday in 1964
to all Purposes

$$\begin{aligned} & 0.142 \times \text{Population 5 years and Older} \\ & + \\ & 0.352 \times \text{Number of Households} \\ & + \\ & 0.250 \times \text{Number of Cars Owned} \end{aligned}$$

Both equations show the high degree of relationship between trips generated at home and the characteristics of the resident population. The correlation coefficients, a statistical reliability measure, substantiate this relationship and show it to be highly significant.

Equation 1: Correlation Coefficient is 0.98

Equation 2: Correlation Coefficient is 0.96

Applying these equations to a summary of the population characteristics of residents of Metropolitan Toronto estimates of total traffic produced from home during an average weekday and during the 7-9:00 AM period can be made.

Summary of Population Characteristics of Residents
of Metropolitan Toronto

Population	1,813,000
Population 5 years and Older	1,602,000
Number of Households	479,000
Number of Cars Owned	456,000

Travel estimates are shown in the following figures:

Figure 3.1
(Equation 1)

Trips Generated at Home on Average Weekday in 1964
Destined to All Purposes

	$0.318 \times 1,602,000$	}	510,000 trips
	+		
<div>Total Trips 1,135,000</div>	$0.458 \times 479,000$	}	219,000 trips
	+		
	$0.890 \times 456,000$	}	406,000 trips
			<hr/>
	Total Estimated Travel		1,135,000 trips
	<u>The 1964 Survey Reports</u>		<u>1,136,000 trips</u>

An arrow points from the 'Total Trips 1,135,000' box to the 'Total Estimated Travel' row.

Figure 3.2
(Equation 2)

Trips Generated at Home During 7-9 AM on Average Weekday in 1964
Destined to All Purposes

		$0.142 \times 1,602,000$	}	228,000 trips
		+		
		$0.352 \times 479,000$	}	169,000 trips
		+		
		$0.250 \times 456,000$	}	114,000 trips
				<hr/>
		Total Estimated Travel		511,000 trips
		<u>The 1964 Survey Reports</u>		<u>510,000 trips</u>

Total Trips
(7-9 AM)
511,000

=

Close agreement is observed between estimated traffic and traffic reported by the 1964 Home Interview Survey. Although not demonstrated here similar agreement occurs between estimated traffic and survey counts for each of the major trip purposes.

Using the known 1964 population characteristics travel estimates were made based on the relationships derived from the 1956 survey. These estimates are shown in Figures 3.3 and 3.4.

Figure 3.3
(Equation 1 - 1956)

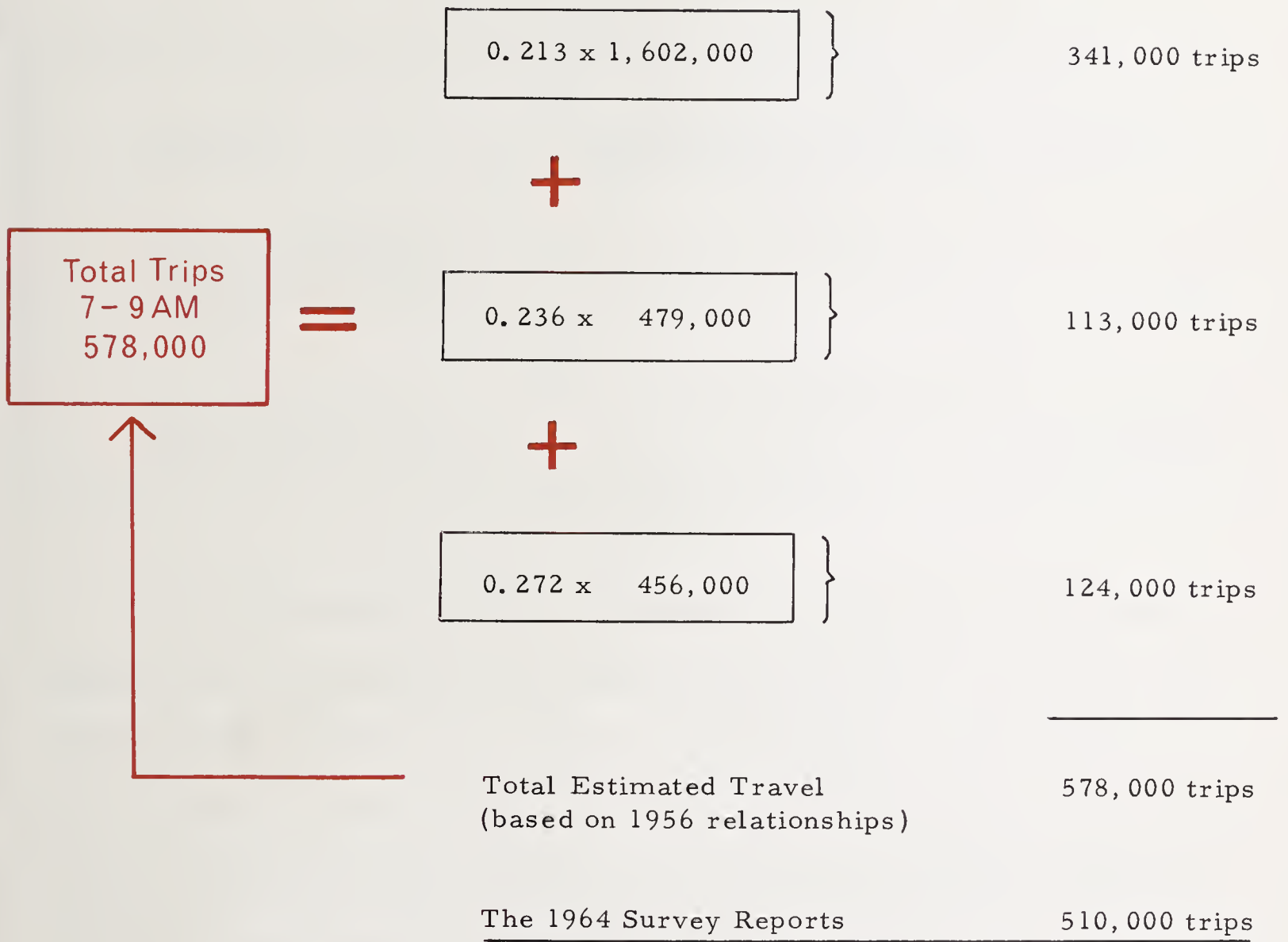
Trips Generated at Home on Average Weekday in 1964
Destined to All Purposes

		$0.452 \times 1,602,000$	}	724,000 trips
		+		
<div style="border: 1px solid red; padding: 5px; display: inline-block;"> Total Trips 1,225,000 </div>	=			
		$0.162 \times 479,000$	}	78,000 trips
		+		
		$0.927 \times 456,000$	}	423,000 trips
				<hr/>
		Total Estimated Travel (based on 1956 relationships)		1,225,000 trips
		<u>The 1964 Survey Reports</u>		<u>1,136,000 trips</u>

(A red arrow points from the bottom of the 'Total Trips' box to the 'Total Estimated Travel' line)

Figure 3.4
(Equation 2 - 1956)

Trips Generated at Home During 7-9 AM on Average Weekday in 1964
Destined to All Purposes



A comparison of Figure 3.1 with Figure 3.3 and Figure 3.2 with Figure 3.4 indicates that the 1956 relationships overestimate the actual 1964 traffic as shown in Table 3.1.

Table 3.1

Comparison of Traffic Estimates Based on
1964 and 1956 Relationships

Equation	Traffic Estimates		
	1964 Relationship	1956 Relationship	1956-1964 Difference
1. Trips generated at Home on an Average Weekday	1,135,000	1,225,000	90,000 (8% of 1964)
2. Trips generated at Home during 7-9 AM	510,000	578,000	68,000 (13% of 1964)

It is observed that the 1956 relationships overestimate the 1964 traffic by approximately 8 percent for all day travel and approximately 13 percent for the 7-9 AM period. However, the overall per capita trip rate of approximately 1.4 trips per person remains the same as for 1956 as does the distribution by purpose of trip. The reason for this overestimate is to be found in the 1956 estimating equation for home-based trips destined for shopping, school and personal business during the 7-9 AM period. A comparison between the 1964 and 1956 relationships used to estimate home-based travel to shopping, school and personal business from 7-9 AM on the basis of the 1964 population characteristics is made in Figure 3.5.

An overestimate of close to 47,000 home-based person trips to shopping, school and personal business from 7-9 AM is made by using the 1956 estimating relationships. This accounts for 70 percent of the overestimated value. It is due to a failure to link serve passenger or change of mode trips to the initial home-based leg of the trip in the derivation of the 1956 relationships. Approximately 46,000 person trips are reported in the 1964 survey to be home-based and destined to serve passenger or change of mode purposes. By combining the majority of these with the non home-based work leg of the trip a more accurate evaluation of travel generation was developed in the 1964 survey. This procedure was not followed in 1956 resulting in an average total trip estimate approximately 10 percent in excess of the actual value.

Due to the symmetry of travel to and from home identical relationships describe traffic flow destined to home with respect to the household characteristics. Thus the findings applicable to travel originating at home may be assigned equally well to traffic destined to home.

Figure 3.5

Comparison Between 1964 and 1956 Relationships to Estimate
Home-Based Trips to School, Shopping and Personal Business from
7-9 AM on an Average Weekday in 1964

A. 1964 Relationship

<div style="border: 2px solid red; padding: 5px; display: inline-block;"> Total Trips to Shopping etc. (7 - 9 AM) 85,000 </div>	=	<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.053 x 1,602,000</div>	}	85,000 trips
		<div style="text-align: center;">-</div>		
		<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.108 x 479,000</div>	}	52,000 trips
		<div style="text-align: center;">+</div>		
		<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.113 x 456,000</div>	}	52,000 trips
				<hr/>
		Total Estimated Travel		85,000 trips
		<u>The 1964 Survey Reports</u>		<u>86,000 trips</u>

B. 1956 Relationship

<div style="border: 2px solid red; padding: 5px; display: inline-block;"> Total Trips to Shopping etc. (7 - 9 AM) 133,000 </div>	=	<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.030 x 1,602,000</div>	}	48,000 trips
		<div style="text-align: center;">-</div>		
		<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.090 x 479,000</div>	}	43,000 trips
		<div style="text-align: center;">+</div>		
		<div style="border: 1px solid black; padding: 5px; display: inline-block;">0.487 x 456,000</div>	}	224,000 trips
				<hr/>
		Total Estimated Travel		133,000 trips
		<u>The 1964 Survey Reports</u>		<u>86,000 trips</u>

2. Trip Distribution - Where People Travel

The number of trips between any two zones for a particular trip purpose is dependent on the total number of trips generated for distribution at the trip origin (G_i) the total number of trips attracted to the destination (A_j), and the travel friction or impedance between the origin and destination as measured by the time factor (TF_{ij}).

The following formula is applied to describe this relationship, and hence to determine the trips distributed between each origin and destination zone:

$$J_{ij} = KG_i A_j TF_{ij} \quad i, j = 1, \dots, N \text{ zones} \quad (1)$$

where: J_{ij} = number of trips leaving origin i for destination j for the purpose in question.

G_i = total trips generated at origin i for this purpose.

A_j = total trips attracted to destination j for this purpose.

TF_{ij} = time factor for trips made between origin i and destination j for this purpose, that is $e^{-BT_{ij}}$.

where: B = parameter to be determined.

e = 2.718

T_{ij} = travel time between i and j .

The constant K is an adjustment factor so that the following equalities are satisfied:

(i) Total trips leaving origin i equals total trips generated there, i. e.

$$\sum_{j=1}^N J_{ij} = G_i$$

(ii) Total trips arriving at destination j equals total trips attracted there, i. e.

$$\sum_{i=1}^N J_{ij} = A_j$$

The formula (1) is well known as "gravity formula" so called because of its similarity to the formula derived by Newton to describe gravitational attraction between two masses.

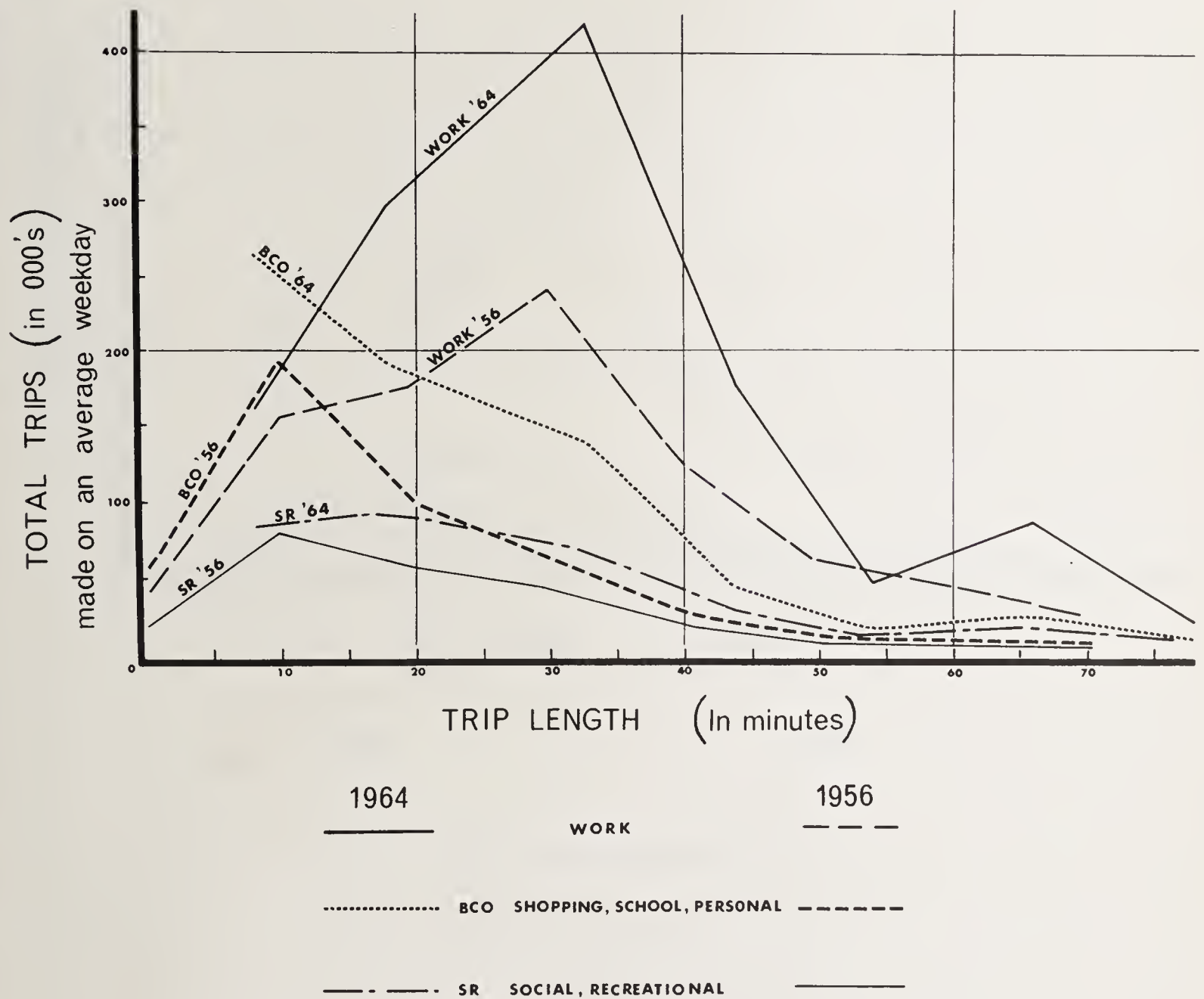
A detailed description of this gravity formula is given in the Report 1 "Transportation Research Program, Appendix II" prepared by the Metropolitan Toronto Planning Board 1962. All necessary parameters associated with this formula were first derived from the 1956 Home Interview Survey in Metropolitan Toronto. During December of 1964, the basic gravity formula was re-established with the 1964 Home Interview Survey data, for the AM travel period (7-9 AM).

This basic formula was re-established for each of the major trip purposes, i. e.

1. trips between home and work.
2. trips between home and shopping, school or personal business.
3. trips between home and social recreation.

The principal relationship incorporated in the gravity formula is the relationship between the frequency of travel and the length of travel (in minutes). It is this relationship which describes the influence of travel friction on trip distribution and hence establishes the value of the parameter "B" of the gravity formula. This relationship is shown in Figures 4 and 5 for each major trip purpose, based on the 1964 survey data. Also, the relationships based on the 1956 survey data are shown in the same figures for comparison. Figure 4 shows the relationship for trips made during an average weekday and Figure 5 shows it for trips made during an average

COMPARISON OF THE RELATIONSHIP BETWEEN TOTAL TRIPS MADE ON AN AVERAGE WEEKDAY AND TRIP LENGTH IN 1964 AND 1956



COMPARISON OF THE RELATIONSHIP BETWEEN TOTAL TRIPS MADE DURING AN AVERAGE 2 HR. PEAK PERIOD & TRIP LENGTH IN 1964 & 1956

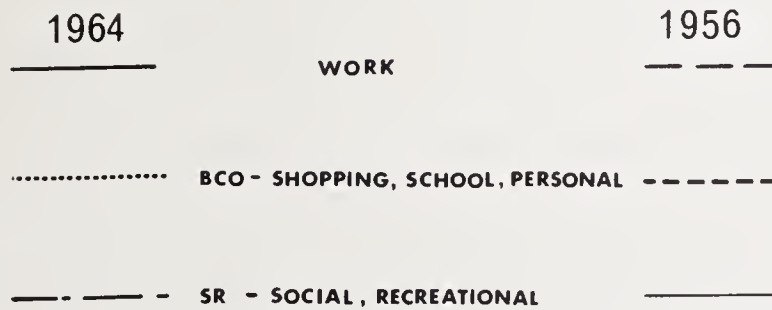
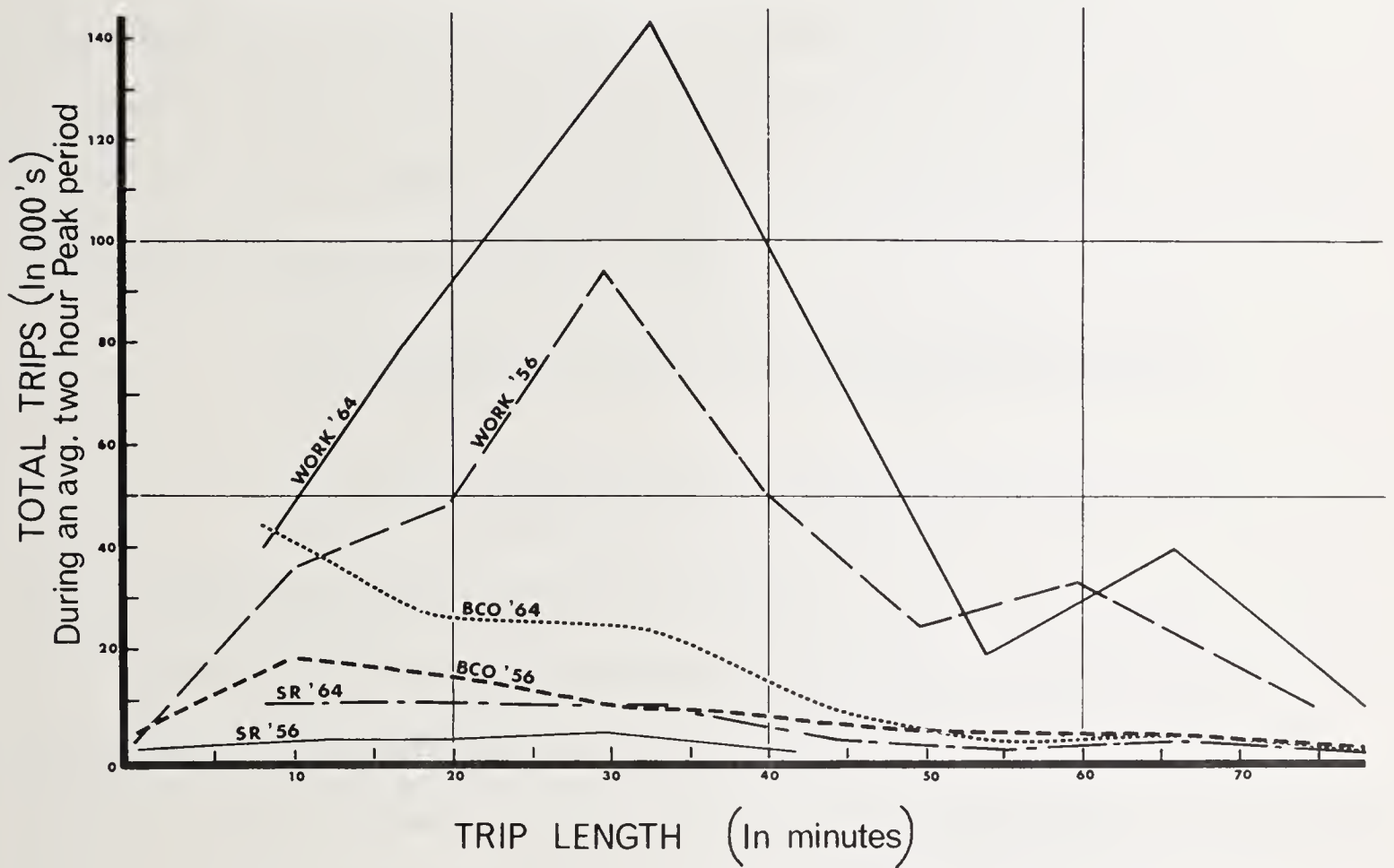


FIG. 5

two hour peak period.

Careful investigation of the relationships between frequency of travel and trip length as shown in Figures 11 and 12 discloses general agreement between the findings of the 1964 and 1956 surveys. People appear to spend approximately the same time travelling in 1964 as they did in 1956. On the basis of this evidence, it is concluded that the gravity formula established on the basis of the 1956 data is still applicable in the planning process. Consequently, the following recommendations are made:⁴

1. The time factor associated with travel to work be based on "B" parameter value of 0.04 as established from the 1956 survey.
2. Time factor associated with travel to other purposes be based on "B" parameter value of 0.08.

3. Travel Mode Split - How People Travel

People choose to travel by public transportation facilities OR private automobile in accordance with the relative travel times, the travel costs, the regularity and convenience of transit service, the economic status of the population and trip purpose. In this analysis the comparative advantages and disadvantages of these two travel modes were measured by time, cost and convenience criteria. Economic status and trip purpose are market characteristics which affect user reaction to the first three factors. Eighty diversion curves were established for work travel from the 1964 Home Interview Survey data to demonstrate quantitatively

4. The recommended "B" parameter values were tested in the 1965 Traffic Model Calibration, July, 1965.

the relationships between transit usage and the travel time ratios for each of 4 levels of cost ratio, 4 levels of service ratio and 5 levels of economic status as indicated below:

(a) Cost Ratio

<u>Level</u>	<u>Transit Cost/Auto Cost</u>
1	0.0 to 0.5
2	0.5 to 1.0
3	1.0 to 1.5
4	1.5 and over

(b) Service Ratio

<u>Level</u>	<u>Transit Service/Auto Service</u>
1	0.0 to 1.5
2	1.5 to 3.5
3	3.5 to 5.5
4	5.5 and over

(c) Worker Income

<u>Level</u>	<u>Annual Income Per Worker</u>
1	0 to \$3,190
2	\$3,190 to \$4,840
3	\$4,840 to \$6,380
4	\$6,380 to \$8,030
5	\$8,030 and over

Travel times were the times spent en route from door to door. To make direct comparison with calculations of 1954 transit usage possible incomes have been adjusted to coincide with the 1961 cost of living index.

Data from the 1964 Home Interview Survey was combined in a manner to minimize the inherent sampling error. Thus the Metropolitan Toronto Planning Area was divided into 147 study zones where each study zone comprised one or

more survey data areas (census tracts or traffic zones). Average travel costs by transit and by private automobile were established from each zone to every other zone. Similarly, average waits, walks and transfer times were calculated. These estimates of travel characteristics were based on the information of the survey as well as reports of the Toronto Transit Commission. Auto operating costs per mile of travel were empirically established by a previous study.⁵

Public usage of transit facilities (as a percentage of all origin-destination trips), door to door travel times by transit and by automobile, walking times, parking costs etc and income per worker were ascertained from the 1964 Household Survey.

The above information was summarized and applied to the following equations.

$$1. \quad \text{Travel Time Ratio} = \frac{TQ + WKQO + WKQD + WQ + TR}{TV + WKVO + WKVD + WVO + WVD}$$

where: TQ = time en route in transit vehicle

TV = time en route in private automobile

(for explanation of the other symbols see Service Ratio page 24)

$$2. \quad \text{Cost Ratio} = \frac{FR}{[CF + CO + (PKO + PKD)/2]/NPPV}$$

where: FR = transit fare

CF = gasoline cost

$$\frac{(\text{gallons} \times \text{distance} \times \text{cost})}{\text{mile} \quad \text{gallon}}$$

5. G. Haikatis and H. Joseph, "Economic Evaluation of Traffic Networks" mimeograph - 40th Annual Meeting, Highway Research Board, January 9-13, 1961.

CO = oil change and lubrication cost
$$\frac{(\text{cost of oil change} \times \text{distance})}{\text{mile}}$$

PKO = parking cost at origin of trip

PKD = parking cost at destination of trip

NPPV = number of passengers per vehicle

3.
$$\frac{\text{Service Ratio}}{\quad} = \frac{WKQO + WKQD + WQ + TR}{WKVO + WKVD + WVO + WVD}$$

where: WKQO = time spent walking from trip origin to transit vehicle

WKQD = time spent walking from transit vehicle to destination

WQ = time spent waiting for transit vehicle

TR = time spent transferring between transit vehicles

WKVO = time spent walking between trip origin and parking space

WKVD = time spent walking between parking space and trip destination

WVO = parking delay time at trip origin

WVD = parking delay time at trip destination

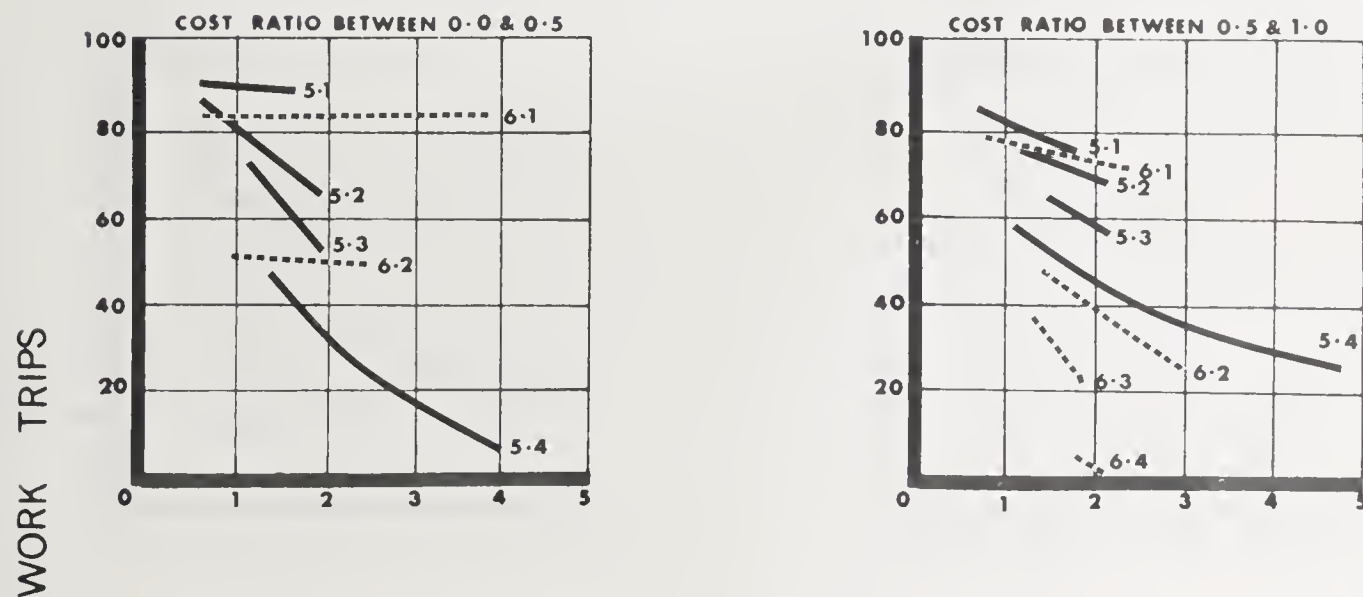
4. Economic status expressed in median income per worker or by other suitable measures.

5. Trip purpose, individually or in combination. Different sets of diversion curves are used for each trip purpose.

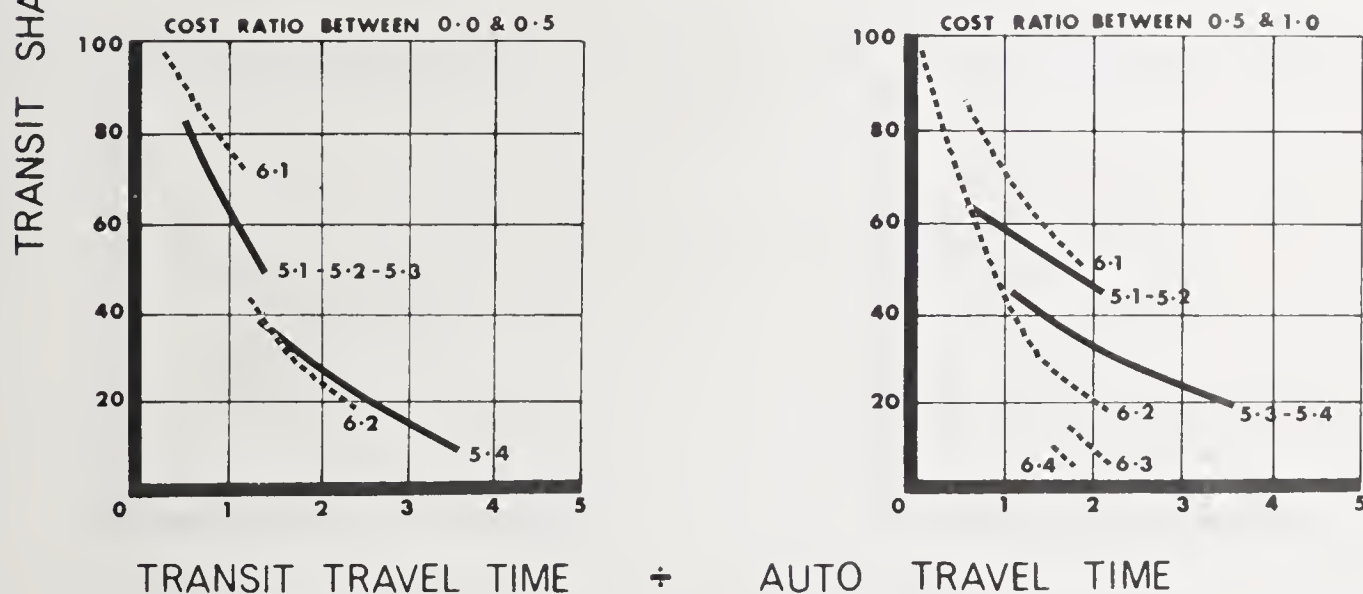
A direct comparison of the 1954 and 1964 relationships for low and middle income workers is shown in Figures 6 and 7. These diversion curves illustrate the percentage of the population in these income categories who choose to travel to

COMPARISON BETWEEN THE 1954 AND 1964 MODAL SPLIT RELATIONSHIPS FOR WORK TRAVEL IN METROPOLITAN TORONTO

Worker Income Between \$3190 & \$4840



Worker Income Between \$4840 & \$6380



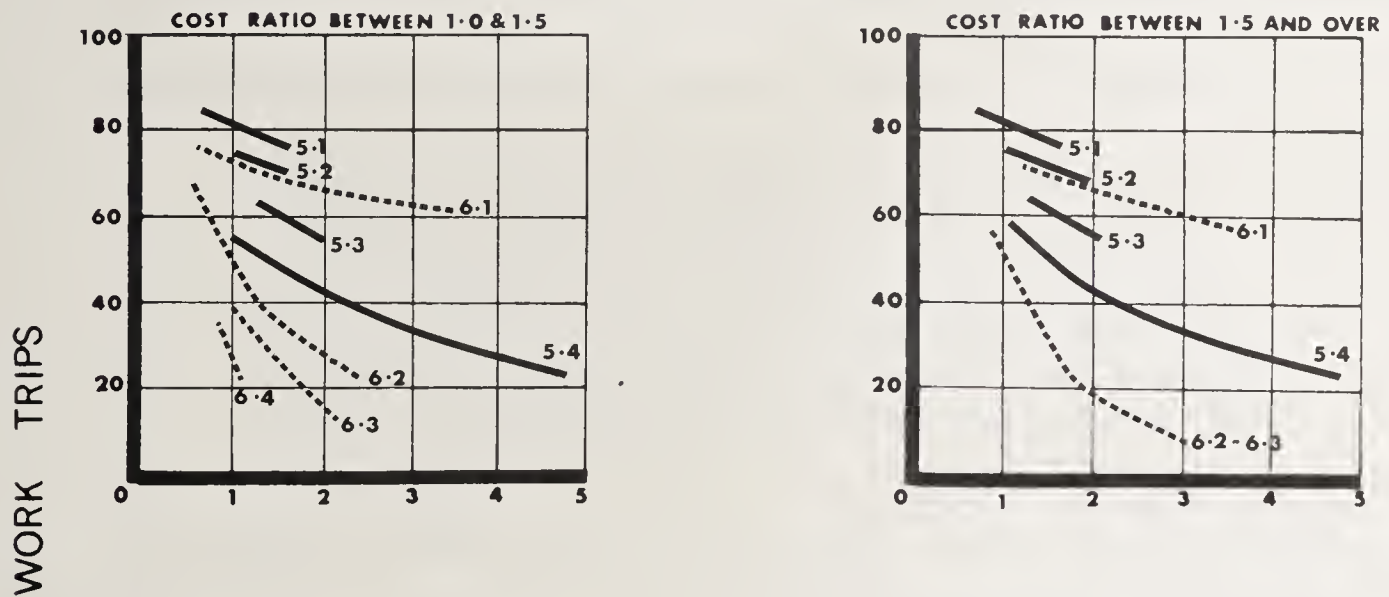
TRANSIT TRAVEL TIME ÷ AUTO TRAVEL TIME

LEGEND

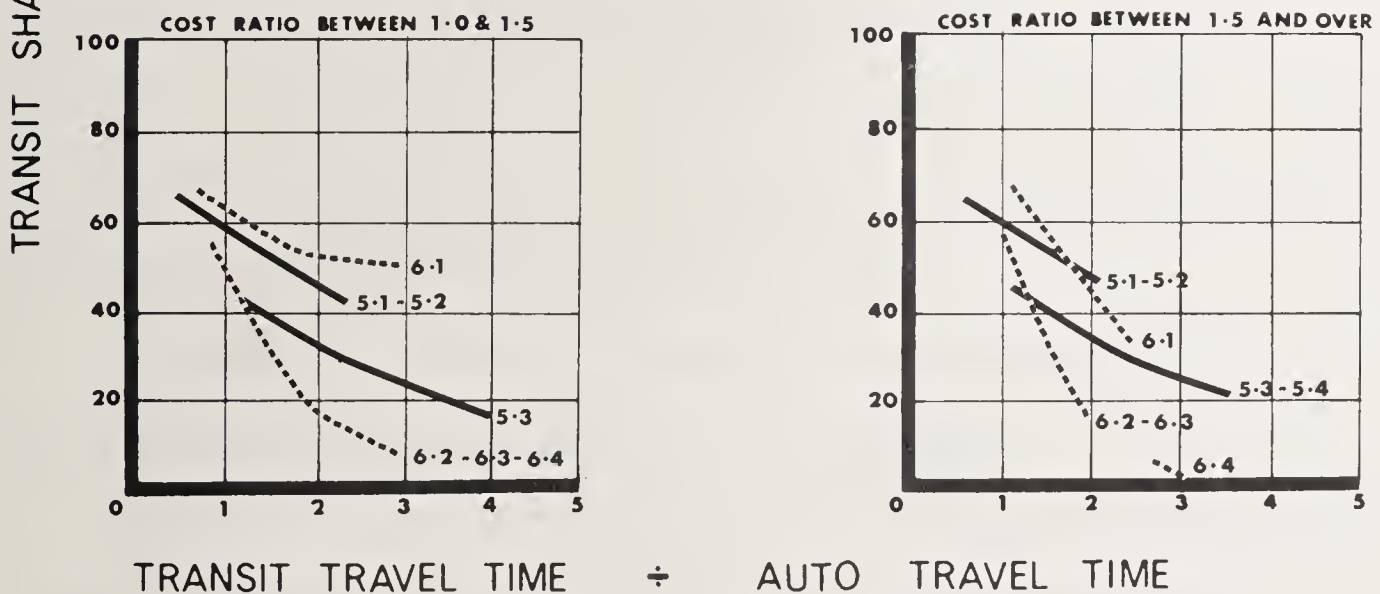
1954 RELATIONSHIP	5 ——— X (SEE SERVICE RATIO BELOW)
1964 RELATIONSHIP	6 ······· X
SERVICE RATIO	1. - BETWEEN 0 AND 1.5
	2. - BETWEEN 1.5 AND 3.5
	3. - BETWEEN 3.5 AND 5.5
	4. - BETWEEN 5.5 AND OVER

COMPARISON BETWEEN THE 1954 AND 1964 MODAL SPLIT RELATIONSHIPS FOR WORK TRAVEL IN METROPOLITAN TORONTO

Worker Income Between \$3190 & \$4840



Worker Income Between \$4840 & \$6380



LEGEND

1954 RELATIONSHIP	5 ——— X (SEE SERVICE RATIO BELOW)
1964 RELATIONSHIP	6 - - - - - X
SERVICE RATIO	1. - BETWEEN 0 AND 1.5
	2. - BETWEEN 1.5 AND 3.5
	3. - BETWEEN 3.5 AND 5.5
	4. - BETWEEN 5.5 AND OVER

work by transit in the AM peak period shown separately for 4 levels of cost ratio and 4 levels of service ratio.

On consideration of all the 1964 and 1954 modal split relationships one may conclude that the basic relationships developed from the 1954 survey data are still applicable in the planning process with this one exception:

- Middle income workers appear to demonstrate a declining preference to ride transit over 10 years, as it becomes less convenient in comparison with motor vehicular travel. This decline in preference for transit occurs when the transit excess travel times exceed auto excess times by at least one and one-half times. The decline seems to occur regardless of the cost of travel by transit.

Provided the transit service is convenient, that is when the walks, waits and transfer times on transit are not more than one and one-half times the walks and parking delays in motor vehicular travel, people in 1954 and now in 1964 appear to demonstrate similar preference for transit ridership. Differences for 1954 and 1964 do not exceed 5 percent and hence are generally insignificant. The difference in ridership on less convenient transit between 1954 and 1964 is as high as 30 percent ridership and therefore appears significant.

Additional investigation of this finding is recommended.

4. Route Assignment - What Route People Follow

Traffic assignment is a term applied to the method of calculating the number of vehicles or persons that would use a given transportation facility under certain given travel conditions.

In the Traffic Prediction Model, the problem of assignment consists of

determining the number of vehicles or persons using each of two or more routes for the same travel mode, given the Origin-Destination interchange movement. The assignment factors are calculated in the Traffic Prediction Model using the route travel times for each O-D pair, by means of the following formula:

$$AF_1 = \frac{(T_1)^{-b(V)}}{(T_1)^{-b(V)} + (T_2)^{-b(V)} + \dots + (T_n)^{-b(V)}} \quad (1)$$

Note: $AF_1 + AF_2 + \dots + AF_n = 1.00$

where: AF_1 = the route assignment factor for route 1 (specifying what percentage of private vehicle travellers are using the first vehicle route for the O-D in question).

T_i = the travel time via the i th route from the O to the D.
 $i = 1, \dots, n$. (There is a total of n routes for the O-D pair in question.)

$b(V)$ = the assignment factor exponent for vehicles which is empirically determined by analysis.

For determining assignment factors within the transit mode, $b(Q)$ would replace $b(V)$ in the formula above.

4.1 Background

The parameter " $b(V)$ " input to early versions of Traffic Prediction Model (IBM 650 and 7070) for the route assignment factor, was established by a search of relevant literature on the subject.⁶ The parameters could not be established empirically for the Metropolitan Toronto Area, due to absence of pertinent survey

6. Reference to a Series of Highway Research Board Bulletins, #61, #130.

data. Satisfactory values of the assignment factor exponent $b(V)$ were employed so that a settlement of traffic flow was achieved. Thus, the values did not always conform with any particular theory of route selection.

4.2 Establishment of 1964 Relationship

As part of the 1964 Transportation Survey approximately 6000 Metropolitan Toronto residents were asked to trace their route to work and to give the reasons for their choice. Accordingly, this survey data was used to derive empirically the assignment factor exponent $b(V)$ of formula (1).

The analysis was conducted in the following steps:

It was important to subdivide the Metropolitan Toronto Planning Area into Study Zones to facilitate data processing. Each study zone was uniquely determined by natural and/or man-made traffic barriers, i. e. rivers, valleys, hydro rights-of-way, expressways, railroad rights-of-way, etc. By defining a study zone in this way we account for the channelization of traffic between study zones but only attribute minor importance to the free circulation within a zone. The empirical study of route choice was facilitated by this delineation of study zones.

The main travel corridors were selected as the corridors containing major transportation facilities, i. e. Gardiner and Don Valley Expressways, Highways #401, #400, #27, #2, #48, and Yonge Street. The alternatives of route choice were established for these main corridors of movement. The following information was assimilated from the survey for each major origin and destination interchange (on a study zone basis):

- (a) Number of alternative routes chosen and their classification according to mix of facilities.
- (b) Frequency of use of each route.
- (c) Travel time for each major route choice.

The final step involved the analytical study of the basic assignment factor formula (1). This formula was established by graphical analysis. The findings of this analysis are presented in Figure 8. It appears that a $b(V)$ exponent of 4 in equation (1) demonstrates the best explanation of route choice by the mathematical equation (1).

5. Summary of Travel Trends

The results of the analysis of travel trends between 1956 and 1964 have been reviewed in this chapter. The findings and their interpretation are briefly described below:

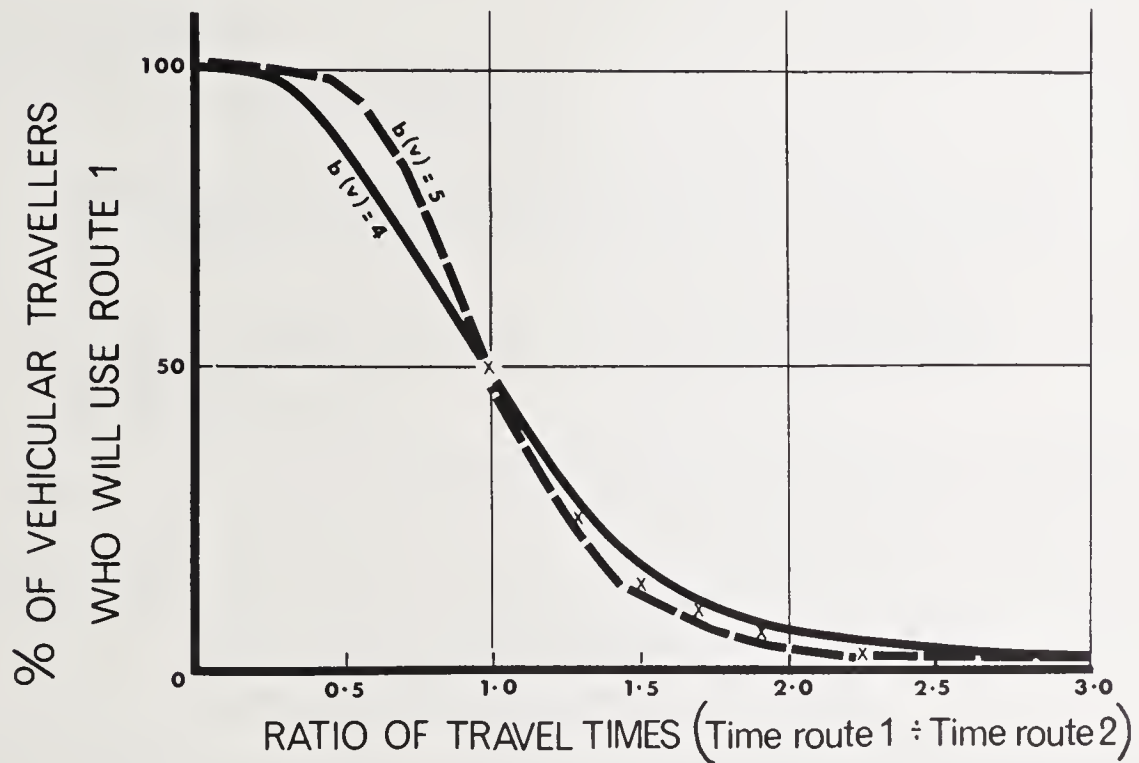
5.1 Trip Production

The following have been shown:

- (i) The 1956 Relationships overestimate person travel in 1964 by approximately 8 to 13 percent for all day and for the AM peak period respectively.
- (ii) This overestimate is mainly attributable to differences between the procedures of deriving the 1956 and 1964 relationships. It has been shown that the linking of serve passenger and change of mode trips will reduce the trip rate by approximately 10 percent. Had the linking procedure been applied in deriving the 1956 relationships little or no difference should exist between 1956 and 1964 relationships.

It is recommended that the 1956 trip production relationships be substituted by 1964 relationships at the earliest opportunity. If one continues to apply, the 1956

TRAFFIC ASSIGNMENT CURVE SHOWING % OF VEHICULAR TRAVELLERS WHO USE ROUTE 1 WHEN CHOICE IS BETWEEN 1 & 2



x - OBSERVATION OBTAINED FROM ANALYSIS OF REPORTED ROUTES

— ASSIGNMENT CURVE $b(v) = 4$

- - - ASSIGNMENT CURVE $b(v) = 5$

ASSIGNMENT FACTOR

$$AF_1 = \frac{(T_1)^{-b(v)}}{(T_1)^{-b(v)} + (T_2)^{-b(v)}}$$

FIG. 8

relationships, the estimates of travel could be in excess by approximately 10 percent. Nevertheless, an overestimate of this magnitude is not considered significant, and would probably not jeopardize a planning decision. Fluctuations of 10 percent or more are often observed in hourly traffic flows on major transportation facilities.

5.2 Trip Distribution

The findings of the analysis show:

- (i) People appear to spend approximately the same time travelling in 1964 as they did eight years ago in 1956.
- (ii) It is concluded that the gravity formula established from the 1956 survey data is still applicable in the planning process.

Therefore, it is recommended that the following "B" parameters be applied in the 1964 Calibration test of the Traffic Model and in all future predictive tests:

B	=	0.04	for travel between home and work
B	=	0.08	for travel to other purposes

Minor adjustments to these values may be applied in the Calibration tests, as required. Any adjustments are best carried out at that time.

5.3 Modal Split

Analysis of people's choice of travel mode disclosed the following:

- (i) Provided the transit service is convenient, people demonstrate similar preference to ride public transportation in 1964 as was their habit in 1956.
- (ii) With transit of lesser convenience, middle income people show a decline in their preference to ride transit in 1964 from their habit in 1956.



SURVEY PROCEDURE

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SURVEY AREA

Consequently, it is recommended that the basic travel relationships (1954) which apply for travel by convenient transit (service ratio 1) are still applicable in the planning process. However, in cases of increasing inconvenience in travel by transit (service levels 2, 3, 4) the 1954 relationships must be adjusted to reflect the decline in preference for transit ridership. This adjustment should be made before the conduct of the 1965 Calibration Test and any future predictive tests with the Traffic Prediction Model.

Predictive tests conducted with the 1954 relationships should still produce valid findings. Provided the relationships were applied to test whether improved transit operations would offer convenient service, the estimates of ridership would be characteristic of people's travel habits in 1964 as well as in 1954. In testing transit systems offering convenient service, both the 1964 and 1956 relationships would provide similar estimates of transit ridership for proposed future transit systems.

In summary, the purpose of this survey was to collect information on the travel by people living and working in Metropolitan Toronto and its surrounding area, inclusive of the five townships of Toronto, Toronto Gore, Vaughan, Markham and Pickering and their towns and villages (see Figure 9).⁷ The data collected included information on household facts and travel facts about trip origins and destinations, method of travel used, and time of day during which trips are made.

The questionnaire adopted for the survey was designed to conform with the general questionnaire advocated by the National Committee on Urban Transportation. This was enlarged to permit the recording of additional information on length of residence and of employment, previous place of residence and employment, and public attitudes on method of travel and travel route used. A copy of the questionnaire is attached for perusal. In summary, the questionnaire was comprised of four types of forms:

1. Form 1: for the household report
2. Form 2: for special household facts
3. Form 3: for the travel or trip report
4. Form 4: for the special work trip report

The design and preparation of the survey forms followed a series of organizational meetings and a Pilot Survey. The Pilot Survey was conducted with a special

7. Specifications of survey are reported in "Proposal to Conduct Home Interview Survey in the Metropolitan Toronto Planning Area", prepared for the Metropolitan Toronto Planning Board by Traffic Research Corporation Limited, March, 1964.

HOUSEHOLD
REPORTMETROPOLITAN TORONTO PLANNING BOARD
TRANSPORTATION SURVEY 1964Zone No.
Sample No.

MEMBERS OF THE HOUSEHOLD are requested to complete this form.

YOUR ANSWERS WILL BE CONFIDENTIAL AND WILL BE USED FOR STATISTICAL PURPOSES ONLY. No name or signature is needed.

A. How many persons live at this address? (Do not include visitors.)

B. How many are children under 5 years of age?

C. How many are servants living in, or roomers?

D. How many passenger cars are owned by persons at this address? (Include station wagons, jeeps)

E. How many company or leased cars are used and garaged here? (Include station wagons, jeeps)

F. How many trucks or vans are used and garaged here?

G. List the persons 5 years of age and older who live at this address. Include servants who live in or roomers. List visitors who live outside the survey area but are temporarily staying at this address.

Person Identification Number	Person Identification (For example, father, mother, son-John, daughter-Mary)	Check (✓) if interviewed	Sex (✓)		Age Group (date code shown below)	Driver's Licence? (✓)		Did You Make Trips? (SEE FORM 3)			Occupation What do you do? (clerk, machine operator, cook, agent, retired, housewife, student, unemployed, etc.)	Industry In what type of business or industry do you work? (car manufacturing, bakery, hotel, fire dept, etc.)
			1 M	2 F		1 Yes	2 No	1 Yes	2 No	3 Not known		
1	Head of Household											
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
98	Visitor											
99	Visitor											

Age Groups
Code5-10
111-15
216-20
321-25
426-35
536-45
646-55
756-65
8over 65
9

PLEASE SEE OVER

Complete for HEAD OF THE HOUSEHOLD.

THE ANSWERS ARE COMPLETELY CONFIDENTIAL AND WILL BE USED FOR STATISTICAL PURPOSES ONLY. No Name or signature is needed.

1.

What type of residence do you occupy **now**? (Circle the code)

Single detached

1

Attached (semi-, row-, or maisonette)

2

Duplex, 3, 4, 5, or 6 Plex

3

Apartment or residential hotel (6 or more apartments)

4

Rooming house (10 or more rooms available as lodgings)

5

Residence attached to business

6

2.

HOW IMPORTANT was **each** of the following reasons when you selected this place of residence:

(Circle the degree of importance, one code number per line)

Good price or rent for residence

1

or

2

or

3

or

4

Neighbourhood

1

or

2

or

3

or

4

Easy to get to by road

1

or

2

or

3

or

4

Easy to get to by public transportation

1

or

2

or

3

or

4

Quality of schools

1

or

2

or

3

or

4

Neor to schools

1

or

2

or

3

or

4

Neor to parks and playgrounds

1

or

2

or

3

or

4

Neor to work (Reasonable Travel Time)

1

or

2

or

3

or

4

Neor to local shopping centre

1

or

2

or

3

or

4

Neor to motor shopping centre

1

or

2

or

3

or

4

Neor to friends and family

1

or

2

or

3

or

4

Neor to church

1

or

2

or

3

or

4

Other

(Please specify)

1

or

2

or

3

or

4

3.

How long have you lived at **this** address?

_____ years _____ months

4.

Where did you live **previously**? (address)

Number Street Municipality or Lot Concession on Municipality if unknown describe location

5.

Where do you work **now**? (address)

Number Street Municipality or Lot Concession on Municipality if unknown describe location

6.

How long have you worked at **this** address?

_____ years _____ months

7.

Where did you work **previously**? (address)

Number Street Municipality or Lot Concession on Municipality if unknown describe location

8.

Approximate Annual Household Income — combined wage and salary income of all members of the household (Circle the code)

under \$ 2,000

1

\$ 6,000 - \$ 8,000

4

\$12,000 - \$16,000

7

\$ 2,000 - \$ 4,000

2

\$ 8,000 - \$10,000

5

\$16,000 - \$20,000

8

\$ 4,000 - \$ 6,000

3

\$10,000 - \$12,000

6

over \$20,000

9

Members of household, servants who live in, roomers and visitors who live outside survey area, each complete a separate form. If more than 6 trips use additional forms.

Zone No.
Sample No.
Person No.

(Please use same identification as on Household Report 1)

[illegible]

IF REPORT INCLUDES AT LEAST ONE WORK TRIP AS CAR DRIVER, BY PUBLIC TRANSIT OR BY RAILWAY SEE REVERSE SIDE

**4
TO WORK
TRIP
REPORT**

To be completed by each person who made a JOURNEY TO WORK, as a CAR DRIVER or by PUBLIC TRANSPORTATION
Please complete either section I or section II for the trip mode on the reverse side.

(Report for the first journey if more than one journey mode "to work" during the day.)

**I
FOR CAR DRIVERS ONLY**
(Report only if you drive all the way to work)

A. How important were the following reasons for using the car?

(Circle one code number per line)

- | | Very Important | Important | Not Important | Did Not Apply |
|---|----------------|-----------|---------------|---------------|
| 1. Car necessary to do work
(for example, salesman, doctor, etc.) | 1 | or 2 | or 3 | or 4 |
| 2. Time to travel by car
Time saved? _____ minutes
or Time lost? _____ minutes | 1 | or 2 | or 3 | or 4 |
| 3. Doily cost to travel by car (including parking cost)
Money saved? _____ cents per day
or Money lost? _____ cents per day | 1 | or 2 | or 3 | or 4 |
| 4. Car more convenient | 1 | or 2 | or 3 | or 4 |
| 5. Long walk to public transportation stops
How long a walk at trip start? _____ minutes
How long a walk at trip end? _____ minutes | 1 | or 2 | or 3 | or 4 |
| 6. Long wait for public transportation at start
How long a wait at trip start? _____ minutes | 1 | or 2 | or 3 | or 4 |
| 7. Too many transfers
How many transfers? _____ | 1 | or 2 | or 3 | or 4 |
| 8. Ride by public transportation uncomfortable | 1 | or 2 | or 3 | or 4 |
| 9. Others _____
(Please specify) | 1 | or 2 | or 3 | or 4 |

B. Use attached road map to indicate your route of travel FROM HOME TO WORK

(If "serve passenger" trip is a portion of journey to work, mark start and end of "serve passenger" trip with an S)

C. Why was this route chosen rather than other routes?

(Circle one code number per line)

- | | Yes | No | Did Not Apply |
|---|-----|------|---------------|
| 1. Shortest travel time | 1 | or 2 | or 3 |
| 2. Shortest travel distance | 1 | or 2 | or 3 |
| 3. Traffic is free flowing (least driving strain) | 1 | or 2 | or 3 |
| 4. Enjoy scenery of this route | 1 | or 2 | or 3 |
| 5. Necessary to serve passenger | 1 | or 2 | or 3 |
| 6. Others _____
(Please specify) | 1 | or 2 | or 3 |

**II
FOR PUBLIC TRANSPORTATION PASSENGERS ONLY**
(Report if any portion of journey to work made by public transit or railway)

A. How important were the following reasons for using public transportation?

(Circle one code number per line)

- | | Very Important | Important | Not Important | Did Not Apply |
|--|----------------|-----------|---------------|---------------|
| 1. Do not own a car | 1 | or 2 | or 3 | or 4 |
| 2. Do not have driver's licence | 1 | or 2 | or 3 | or 4 |
| 3. Car used by other persons | 1 | or 2 | or 3 | or 4 |
| 4. Time to travel by public transportation
Time saved? _____ minutes
or Time lost? _____ minutes | 1 | or 2 | or 3 | or 4 |
| 5. Doily cost to travel by public transportation
Money saved? (including cost for parking) _____ cents per day
or Money lost? (including cost for parking) _____ cents per day | 1 | or 2 | or 3 | or 4 |
| 6. Safer than by car | 1 | or 2 | or 3 | or 4 |
| 7. Public transportation more convenient | 1 | or 2 | or 3 | or 4 |
| 8. Long walk from parking lot to work
How long a walk _____ minutes | 1 | or 2 | or 3 | or 4 |
| 9. Others _____
(Please specify) | 1 | or 2 | or 3 | or 4 |

B. Use attached road map to indicate your route of travel FROM HOME TO WORK

(If "change travel method" trip is a portion of journey to work, mark start and end of "change travel method" trip with a C)

C. Why was this route chosen rather than other routes?

(Circle one code number per line)

- | | Yes | No | Did Not Apply |
|-------------------------------------|-----|------|---------------|
| 1. Shortest travel time | 1 | or 2 | or 3 |
| 2. Shortest travel distance | 1 | or 2 | or 3 |
| 3. Prefer to ride subway | 1 | or 2 | or 3 |
| 4. Seat available | 1 | or 2 | or 3 |
| 5. Fewest transfers | 1 | or 2 | or 3 |
| 6. Frequent service | 1 | or 2 | or 3 |
| 7. Scenery | 1 | or 2 | or 3 |
| 8. Others _____
(Please specify) | 1 | or 2 | or 3 |

Zone No. _____
Sample No. _____
Person No. _____

sample of approximately 150 households in Metropolitan Toronto. It provided valuable information on questionnaire design and survey interview techniques.⁸

1. Conduct of Survey

Over 15,500 households in the survey area were interviewed for household and travel facts, from which close to 15,000 usable questionnaires were obtained. Those households which completed questionnaires comprised a representative sample of approximately 2.8 percent of all households in the survey area and were distributed geographically throughout the area in the same proportion as the population centres. Additional households located in the Western Rail Corridor (Towns of Mimico and New Toronto, the Village of Swansea and Long Branch and Township of Toronto) were interviewed, to increase the sample size to approximately 4.5 percent of the total. This intensified sample was to document more accurately the commuting habits of residents in the Western Lakeshore Corridor than it was possible to reveal with the standard sample.⁹ Table 1 shows the number of sample households in each city, town, village and township in the planning area which completed questionnaires. The number of samples is presented with recent counts

8. The results of the Pilot Survey are described in the "Report on Metropolitan Toronto Planning Board Transportation Survey 1964 - Pilot Home Interview Survey".
9. Explanation for increased sample size is reported in "Proposal to Conduct a Survey of Commuters Residing in Southern Portions of Toronto Township with Rail and Bus Commuter Service" prepared for Metropolitan Toronto Planning Board by Traffic Research Corporation Limited, March, 1964.

Table 1

Number of Sample Households Surveyed Compared with
1964 Household Counts

	Number of Sample Households in Survey	* Count of Households in 1964	Percent Sample
City of Toronto	4717	176359	2.7%
Town of Leaside	170	6828	2.5%
Town of Weston	123	3156	3.9%
Town of Mimico	251	6429	3.9%
Town of New Toronto	187	3344	5.6%
Village of Long Branch	108	3287	3.3%
Village of Swansea	124	3224	3.8%
Village of Forest Hill	299	7538	4.0%
Township of Scarborough	1490	64873	2.3%
Township of East York	780	23321	3.3%
Township of North York	2187	91586	2.4%
Township of York	1272	37009	3.4%
Township of Etobicoke	1672	52275	3.2%
Total - Metropolitan Toronto	13380	479229	2.8%
Township of Toronto and of Toronto Gore	629	18906	3.3%
Town of Streetsville	39	1312	3.0%
Town of Port Credit	73	2294	3.2%
Township of Vaughan	117	4537	2.6%
Town of Woodbridge	32	620	5.2%
Town of Richmond Hill	131	4674	2.8%
Township of Markham	108	4202	2.6%
Village of Markham	56	1463	3.8%
Town of Stouffville	45	998	4.5%
Township of Pickering	156	6059	2.6%
Village of Pickering	20	474	4.2%
Town of Ajax	71	1966	3.6%
Total - Fringe Municipalities	1477	47505	3.1%
Total - Planning Area	14857	526734	2.8%
*1964 Counts of Households were obtained from Metropolitan Toronto Planning Board, November, 1964.			

of 1964 households in each municipality. A constant sample rate of 2.8 percent was difficult to maintain due to the lack of accurate household counts at the time of the survey. Accurate counts were only available by November 1964.

The sample of households selected for the survey was obtained from special listings of customers of municipal Hydro Commissions and of the Ontario Hydro Commission for rural districts.¹⁰ Each Hydro Commission provided a list of 10 (every 10th address) or 20 (every 5th address) percent of all customers (a few commissions provided 100 percent lists), itemizing the addresses and municipality name of the selected households (householder's surname was generally omitted, unless required for positive identification, so as to avoid full disclosure of information). A sample of approximately 1 in 3 in the case of the 10 percent listing and 1 in 6 in the case of the 20 percent listing was chosen for the survey. This source of sample households gave a representative coverage of all households (since over 99.5 percent of households were serviced by Hydro on one meter). In comparison, the Bell Telephone reported 96 percent coverage of Metropolitan Toronto households of which 5 to 20 percent, varying by the district, were with unlisted coverage (no listing in telephone book). Other methods of selecting households, by observation and on-the-street counting, were not preferred due to the probability of erroneous counts occasioned by the high percentage of multiple housing developments in this area.

10. The Metropolitan Toronto Planning Board and their consultant, Traffic Research Corporation Limited, acknowledge the generous assistance and cooperation given by all Hydro Commissions in the Metropolitan Toronto Area, in providing sample lists of hydro customers.

The method of selecting households through the use of Hydro records was highly successful. It is recommended for all future surveys in the planning area.

The selected households were surveyed during the period beginning on April 28, 1964, and ending on June 26, 1964. Equal numbers of households were interviewed on each weekday, Monday through Friday. This was necessary as the frequency of travel is known to vary throughout the week, i. e. Monday travel is approximately 10 percent below the average and Friday travel is 10 percent above the average. Table 2 shows the number of households surveyed throughout the week as a percentage of total households surveyed.

Table 2

Percentage of Households Surveyed on Each Weekday

Monday	Tuesday	Wednesday	Thursday	Friday
19%	21%	19%	21%	20%

Initial contact, with the householders selected, was made by mailing post cards which informed them that they had been chosen to participate in the survey. A few days later, the householders were telephoned and asked for their cooperation in the survey. On agreeing to participate in the survey, the householders were interviewed by one of three survey procedures:

1. Mail-Telephone procedure
2. Telephone procedure
3. Face-to-Face procedure

Each technique is briefly described below:¹¹

1. Mail-Telephone Procedure

Under this procedure the initial telephone call was used to obtain preliminary household information in order to determine how many questionnaire forms of each type should be mailed to the households. Following the telephone agreement the questionnaires were mailed with the required travel day clearly specified. A few days later the householder received a second call as a reminder to complete the forms and return them by mail, or as an offer of assistance by one of the other interview procedures, if so desired.

2. Telephone Procedure

Under this procedure some of the initial household information was obtained over the telephone. If it appeared that the interview could be completed by telephone, as the number of occupants in the household was small and the householders were anxious to complete the interview, the questionnaire was completed at the time. Otherwise, a telephone appointment was made for a later call when all members of the household would be present, or a face-to-face interview was arranged.

3. Face-to-Face Procedure

Lastly, under this procedure, interviews were obtained by personal contact with the householders. Face-to-Face home interviews at the householder's residence

11. Detailed procedure of the Home Interview Origin and Destination Survey is presented in the report "Instruction Manual" prepared for the Metropolitan Toronto Planning Board and Metropolitan Toronto and Region Transportation Study by Traffic Research Corporation Limited.

were of two types: those which were pre-arranged following an initial telephone contact, and those which were initiated on contact as a result of not being able to communicate with the householder by any other means.

The distribution of interviews between the three interview procedures is shown below:

-	Mail	22%
-	Telephone	36%
-	Face-to-Face	42%
		<u>100%</u>

It was recognized at the half way point of the survey that the Mail procedure would not produce sufficient numbers of interviews by the deadline date of June 29, 1964. Accordingly, this procedure was abandoned completely in favour of the Telephone and Face-to-Face procedures. While the Mail procedure appeared to be more economical to execute, it did necessitate a long delay between the mailing of the questionnaires to the householder and the final return of the completed questionnaires. Consequently, this procedure was considered untenable in relation to the tight scheduling of the survey.

Notable differences were observed between the reported results of the Mail interviews and the other two procedures. The householders who cooperated fully in the Mail procedure by returning their completed questionnaires, belonged to a special class of people. It was observed that these households were comprised of one or two people who also appeared to travel frequently. The number of reported trips per person in households interviewed by each procedure is summarized below:

1.	Mail	1.60	trips per person in household
2.	Telephone	1.35	trips per person in household
3.	Face-to-Face	1.30	trips per person in household

(These statistics apply to households surveyed within Metropolitan Toronto.) The slightly lower trip rate from Face-to-Face interviews in comparison to the trip rate of Telephone interviews was anticipated. Face-to-Face interviews were as a rule conducted with ethnic or low income householders. Such householders usually make few trips. Both Telephone and Face-to-Face procedures of interviewing were conducted with middle and high income householders.

The coding, manual editing and validity checking of the data was completed by August 1964. The following check and control procedures were followed in the conduct of this work:

- (a) Interviewers were instructed to review all completed questionnaires prior to submitting them for editing.
- (b) All questionnaires were completely edited. In editing, the information of the survey questionnaire was reviewed for its accuracy and consistency. Further, the questionnaires were organized into batches of 100 forms. At least 25 forms in each batch were re-edited. If the error rate in the 25 forms exceeded the control figure all forms were re-edited in the batch.
- (c) All questionnaires were completely coded. Further, 25 forms in each batch of 100 were re-coded and errors were corrected. If the error rate exceeded the control figure, all forms of the batch were re-coded.
- (d) All data from the questionnaires were keypunched. The keypunching was completely verified by duplicate punching by a different operator. Further, 5 forms out of 100 were re-verified. When the error rate exceeded the acceptable control value all forms were re-verified. Keypunching of approximately one hundred and thirty-five thousand (135,000) punched cards (9 per household) were completed during September 1964.
- (e) All household and trip data on punch cards were sorted by zone, sample and person number and were tabulated on listings. A visual check for missing cards and obvious errors was conducted with all listings. Missing cards were replaced in the card decks and errors in the data were corrected.

Note: A special report prepared on error rates and survey control figures is included as Appendix B of this report.

During September and October 1964, all survey data were transferred to Univac 1107 magnetic tapes. Once the data were transferred to magnetic tapes, the tapes were integrated into the MTPB Data Bank.¹² Copies of tapes are available for the Metropolitan Toronto Planning Board for inspection. All survey data have been copied onto a single Univac 1107 magnetic tape in an integrated household trip format. Details of this operation are described in special memoranda of TRC files.¹³

It has been mentioned previously that the sample households were selected to be representative of all households in the Planning Area. To do so, it was necessary to expand the survey report of these representative households. For each data zone¹⁴ the number of survey households was compared with the total household counts received for the Planning Area, and the basic expansion factor was based on the ratio of actual households to the number of sample households. Further, special adjustments were made to account first for people who made trips but for purposes not reported, and second for an expected under-reporting of trips. (See Validity Checks 1.) Mathematically, the procedure for expanding the trip file was as follows:

$$\text{Household expansion factor} = \frac{\text{Household counts by data zone}}{\text{sample households}}$$

12. Details of the MTPB Data Bank are described by Appendix C, prepared for the Metropolitan Toronto Planning Board by Traffic Research Corporation Limited, March 1965.
13. A Program and Data Format File was prepared for the Metropolitan Toronto Planning Board by Traffic Research Corporation Limited, March 1965.
14. Data zones comprised Census tracts in the Metropolitan Toronto Corporation Area, and Traffic zones in the fringe of the Planning Area. Detailed Zone Maps which delineated geographical zone boundaries at 1:50000 scale, were prepared for the Metropolitan Toronto Planning Board, June 1964.

$$\text{Trip expansion factor} = \text{Household factor} \times \frac{(100 + \text{UT})}{100} \times \frac{(100 + \text{UR})}{100}$$

where: UT means that for each 100 persons who report trips, a small number UT report trips unknown.

UR means that for each 100 persons who report trips a small number UR made trips but did not report them (see next section on Validity Checks for value of UR).

An average zonal expansion factor of approximately 40 was applied to expand travel reported in the survey to total travel throughout the Planning Area. (The zonal factors varied between 30 and 70, with an average of 40.) This variation about the average factor was expected. Hydro records did not provide a uniform sample rate by zone, due to the indexing of household files by surname of occupant rather than by geographical zones. Furthermore, the Hydro Commission often provided too many or too few sample household addresses for the data zones.



VALIDITY CHECKS

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In order to check the accuracy of the Home Interview Origin and Destination Survey, special investigations were conducted. It was the objective of these investigations to establish the reliability of the survey to document person travel and householder characteristics in the Metropolitan Area. Special screenline checks of observed travel and reported travel in the survey at the intermediate cordons present findings on the symmetry of travel. Comparisons between reported travel of the 1964 survey and that of previous surveys conducted by the Metropolitan Toronto Planning Board and the Department of Highways of Ontario, further demonstrated the accuracy of survey results. Other comparisons between reported work trip destinations and centres of employment activity were evidence of the accuracy of the survey to disclose people's places of work. Lastly, the accuracy of the survey to report householder characteristics was shown by comparisons with documented findings of the 1961 Decennial Census. Each of the accuracy checks and the findings are described below:

1. Summary of Depth Re-Interviews of Householders

It was normal practice during the conduct of the survey to check interviewers on the quality and accuracy of their work. Such checks were to ensure the completeness of the survey interviews with regard to accuracy of the household and travel reports. Such checks ensured the highest possible accuracy in the reporting of people's travel. In spite of such careful checks, a consistent under-reporting of person travel is expected in origin-destination surveys in large metropolitan areas.¹⁵

15. The official report of the Chicago Area Transportation Study reports that expanded survey trips accounted for 87.6 percent of automobile driver trips intercepted at the cordon. These were reported as "better than average results for an origin-destination survey in a large city." Volume 1, page 31.

In anticipation of the possible under-reporting of travel, special depth interviews were conducted with approximately 550 of the survey householders. These householders were questioned again about their regular and irregular travel (i. e. work and non-work respectively). During this depth interview, the householder described again his travel but for a typical or average day of travel, with no reference to a specified day or date. Accordingly, each household was assessed for the under-reporting of trips in comparison with their household and trip questionnaires.

The findings of the depth interviews confirmed the published results from other transportation studies. Travel on the average was 10 percent under-reported by the survey. Work travel was most accurately reported with approximately 93 percent coverage by the survey. However, travel for the other purposes was less accurately reported with an approximate 88 percent coverage. Table 3 shows the percent of under-reporting of travel by municipalities individually or grouped. These findings were incorporated in the expansion of survey results to provide a complete report of people's travel in the Metropolitan Area, as mentioned in Chapter II.

2. Screenline Check

A comparison between summaries of expanded survey trips and traffic counts at the major intermediate cordon in the Metropolitan Area was conducted. This Intermediate Cordon is bounded on the North by the CPR tracks which are just north of Dupont Street (North Toronto line), on the East by the Don Valley, on the South by the Gardiner Expressway and the Lakeshore Highway and on the West by the CNR railway right-of-way (Allendale line). All trips reported in the survey with trip origins outside the cordon and with trip destinations within the cordon and vice versa

Table 3

Percent Under Reporting of Person Travel by
Home Interview Survey

Measured by Special Depth Survey of 550 Households

Municipality	Percent Under Report of Travel (UR)	
	Work Travel	Non-Work Travel
City of Toronto	13%	9%
Town of Leaside	0%	15%
Town of Weston	0%	15%
Town of Mimico	7%	15%
Town of New Toronto	0%	15%
Village of Long Branch	0%	15%
Village of Swansea	0%	15%
Village of Forest Hill	0%	15%
Township of Scarborough	5%	15%
Township of East York	5%	15%
Township of North York	4%	15%
Township of York	7%	15%
Township of Etobicoke	7%	15%
Total - Metropolitan Toronto	8%	11%
Total - Fringe Municipalities	5%	15%
Total - Planning Area	7%	12%

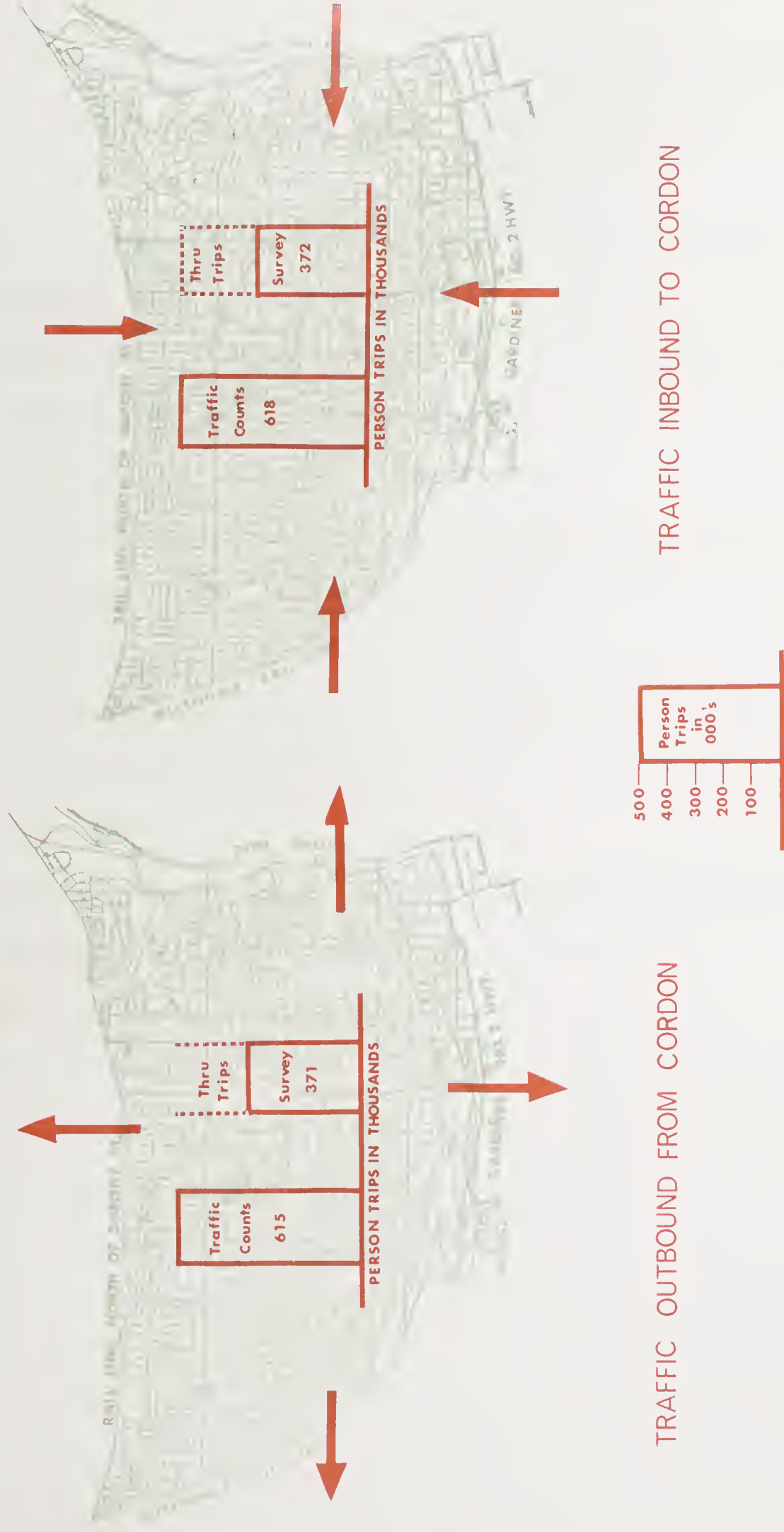
were summarized.¹⁶ These trip summaries for all day travel were compared with 1964 counts of traffic inbound and outbound across the cordon. The findings of these comparisons are shown in Figure 10. As expected, the survey counts are considerably less than the 1964 traffic counts. The difference is expected to be attributable to the extra traffic which passes through the cordons to destinations outside. Due to the influence of this through traffic, the 1964 traffic counts are considered inflated for this comparison.

Summaries of through traffic should be prepared from the survey, and combined with the trip end summaries outlined above. Accordingly, this combined summary of survey trips will be made comparable with the actual cordon traffic counts. This check is more easily conducted in connection with future tests associated with the Calibration of the Traffic Prediction Model to be carried out during 1965. Hence, the complete cordon check should be deferred until a more suitable opportunity for its conduct.¹⁷

It is important to note that the survey results reflect the apparent symmetry of directional traffic. The total inbound traffic and outbound traffic are approximately equal.

16. The 1964 Home Interview Survey of the Metropolitan Toronto and Region Transportation Study and Roadside Surveys of the Department of Highways provided information about person trips originating outside the Planning Area but destined inside. These sources provided the summary record of all external traffic entering the area.
17. It is recommended that Metropolitan Toronto Planning Board complete the Cordon Check, upon the conclusion of their 1964 Model Calibration in May, 1965.

COMPARISON BETWEEN SURVEY TRAVEL ORIGINATING AND DESTINED WITHIN THE INTERMEDIATE CORDON AND ACTUAL TRAFFIC COUNTS AT CORDON



TRAFFIC COUNTS BASED ON 17 HOUR COUNT IN 1963

Mention of the symmetry of travel is made in Chapter on Travel Trends.

3. Checks on Present and Previous Travel Data

Two previous surveys were conducted in the Planning Area and were used as a check against the reported travel rate per capita from the 1964 Survey. A Home Interview Survey was conducted throughout the Metropolitan Toronto Corporation Area in 1956. A second survey was conducted by the Department of Highways of Ontario in 1963, within the Townships of Vaughan, Markham and Pickering and their towns and villages (northern and eastern fringe sections of the Planning Area). These surveys were valuable in that they provided a cross check on the total travel in different sections of the Planning Area. The travel rates per capita, during the average weekday were established from these and the 1964 Survey. A comparison of the trip rates per capita is shown in Table 4. The total travel rate reported from the 1964 Survey agrees with those rates obtained from previous surveys.

4. Comparison Between Survey Work Trip Destination and Employment Counts

Since the Home Interview Survey is conducted at the householder's residence, one naturally expects that the home-based travel, and population and socio-economic facts are accurately described. Sections one, two and the final section five, to follow, are devoted to accuracy checks of this nature. This section describes the accuracy of the survey to reveal non-residential travel information. Total work trips were summarized from the survey by area of work place. These summaries of work trip

Table 4

Comparison Between 1964 Trip Rate and Rate Reported
from Historical Surveys

Area	1964	1963 D. H. O.	1956 M. T. P. B.
Metropolitan Toronto *	1.4 trips per person	not surveyed	1.3 trips per person
Richmond Hill **	1.3 trips per person	1.3 trips per person	not surveyed

* Trip rate per capita for 1956 is determined from information published in the M. T. P. B. Report No. 1 "Transportation Research Program", 1962.

** Trip rate per capita for Richmond Hill in 1963 is reported by Traffic and Planning Studies Sections of D. H. O., January 1965. This figure is tentative and may be subject to change by D. H. O.

destinations were compared with total employment counts¹⁸ for 1964. Considering that the survey was based on home interviews and not on interviews at place of employment, there was remarkable agreement between survey work trip destinations and the employment counts by area. Figure 11 demonstrates the close agreement between work trips and employment for planning districts in the survey area. Close agreement was also obtained for the fine geographical units (census tracts). Generally,

18. Employment counts were obtained from Report on 1964 Employment Survey prepared for the Metropolitan Toronto Planning Board. The survey was conducted by MTPB with National Employment Service Files of firms employing over 10 employees and firms employing under 10 people. Coding and summary of employment files were conducted by Traffic Research Corporation Limited for MTPB.



COMPARISON BETWEEN SURVEY WORK
TRIP DESTINATIONS & 1964 EMPLOYMENT
COUNTS

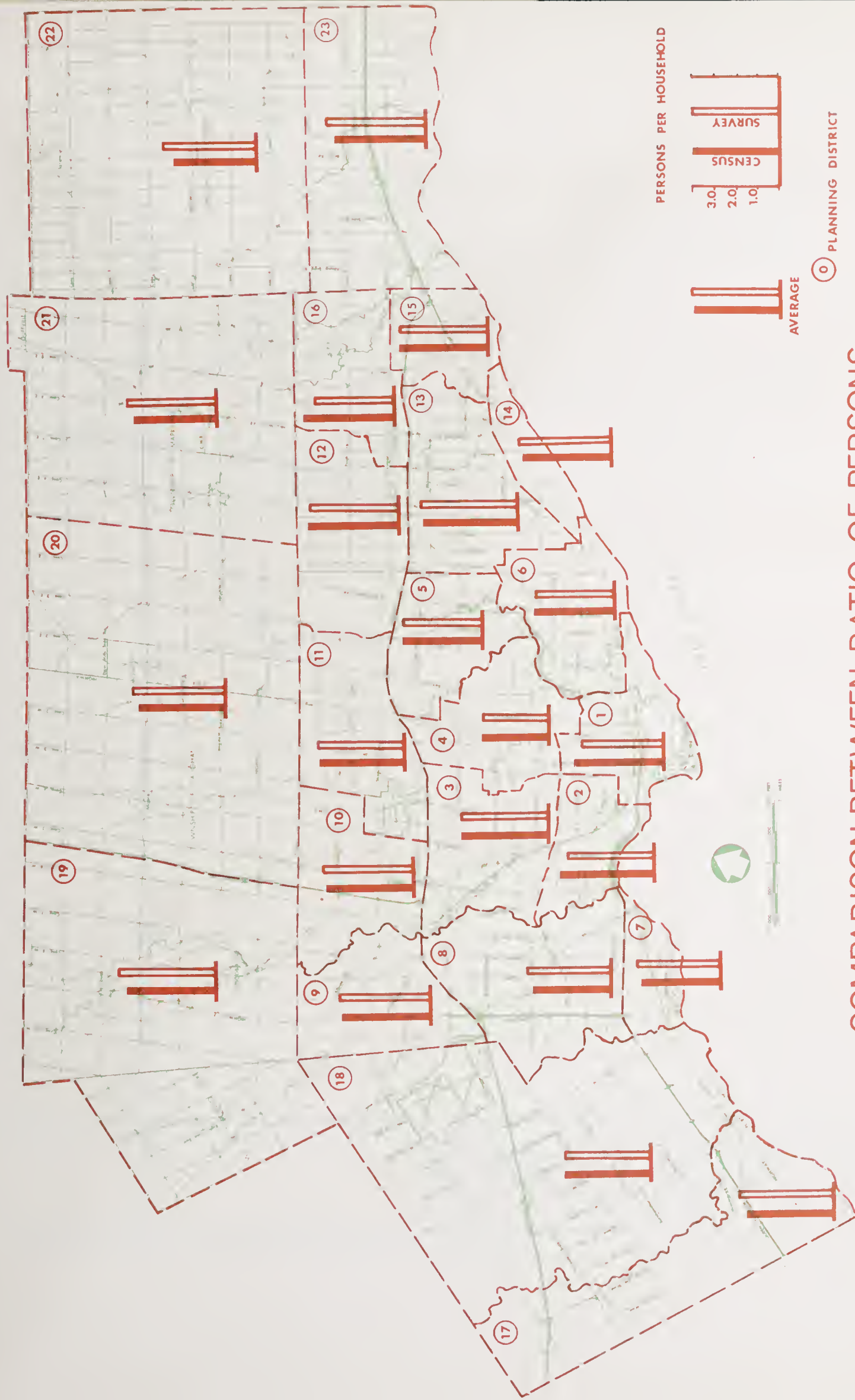
work trip arrivals were 10 to 15 percent less than the stated employment count. This disagreement was expected. At least 10 to 15 percent of the employment labour force are usually absent from work, due to illness, holidays, or for other reasons. The largest difference occurred in District 1, the downtown area, where no doubt seasonal and part time employment is more prevalent for retail and office firms, and where staffs, although registered as employed by downtown companies, are actively engaged in other geographic locations.

In spite of the normal absenteeism, notable agreements between work trip destinations and employment counts occurred in the new and rapidly developing districts. In such cases the Home Interview Survey probably reported more accurately the locations of work for construction employees, than the employment survey. It is recognized that construction employment was recorded in the MTPB Employment Survey at the location of construction office which was often at a different location from the actual construction site(s). Hence, reported work trip arrivals should equal or exceed employment counts for construction areas.

5. Comparison Between Household Characteristics from Survey and from the 1961 Decennial Census

The 1961 Government Census is the base inventory of household characteristics for the Planning Area. Recent household and population counts are generally based on the updating of Census information. The 1964 Survey provides now a new inventory of household facts. Accordingly, it is important that one establishes its reliability for application in the planning process. It must be recognized that the Census is based on 100 percent interview of households for basic facts and a 20 percent interview for special socio-economic facts, as opposed to an average Home

Interview Survey rate of 2.8 percent. Comparisons between the survey summaries of household facts and census information reveal considerable agreements. Noteworthy disagreements occur for newly developed areas for which the 1961 Census no longer accurately reflects characteristics. Figure 12 shows the comparison between population per household for each planning district as reported by the 1964 Survey, and the ratios obtained from the Census.



COMPARISON BETWEEN RATIO OF PERSONS
PER HOUSEHOLD FROM 1964 SURVEY AND
1961 CENSUS



APPENDICES

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APPENDIX A

APPENDIX A

ASSIMILATION AND PRELIMINARY ANALYSIS OF SURVEY DATA

The assimilation and preliminary analysis of the 1964 survey information to permit the derivation of travel relationships is described below.

Prior to actually deriving the relationships which describe why, when, where, how and by what route people travel; preliminary analysis was carried out. These preliminary analysis steps comprise the following:

1. Final computer screening of the data to provide a 99% clean file for derivation of travel relationships.
2. Trip linking whereby individual trips for serve passenger and change of mode purposes are linked to represent a combined trip for the primary trip purpose.
3. Assignment of detailed address codes where addresses are approximately specified or not specified at all.
4. Sorting of Master Trip File.
5. Summary of survey data.

Computer programs were written for the Univac 1107 computer to carry out each of these tasks. Details of these programs are presented below:

1. Final Screening of Data

In spite of quality control and intensive manual editing procedures, a number of errors remained undetected in the data file. A small error rate was expected with such a large number of survey interviews (15,000) and with a questionnaire of such complexity as the MTPB form. The errors which existed in this file were of the following type:

- Interviewer errors i. e. basic data inconsistencies exist, etc.
- Coder errors i. e. invalid address codes outside the range of designated numbers were assigned, etc.
- Editor errors i. e. duplicate household numbers were assigned, etc.
- Keypunch/verifier errors i. e. wrong codes were punched, etc.
- Data processing errors i. e. household and trip cards were misplaced, etc.
- Miscellaneous errors created by computer operators or malfunction of computer etc.

All MTPB survey data was initially screened during October. A second and third computer screening of error data were accomplished during the first week in November. This screening was vital to the analysis of the survey data. Otherwise, serious errors in the data could present a biased picture of travel behaviour.

2. Trip Linking

In certain aspects of investigating travel behaviour, it is desirable to break a trip which involves one or more changes in mode and/or a diversion to serve a passenger, into several simpler trips (for Travel Mode and Route Choice Analysis). However, for the analysis of the Production of trips and the Distribution of trips to work and other purposes, it is desirable to recombine the individual simple trips, into a single trip record, for which the origin of the combined trip is the origin of the first simple trip, and the destination, is the destination of the last simple trip. This combined trip should be for a continuous duration of travelling.

Trip linking was achieved by an 1107 computer program. The programming was completed during October and testing was completed during the first week in November. Production runs with this program were carried out during November.

3. Assignment of Detailed Addresses

The survey questionnaire required the householder to report the street address and municipality for the following locations:

- origin zones of all trips
- destination zones of all trips
- address lived previously
- address worked now
- address worked previously

Regretably, at least 3 to 5 percent of the householders were either unwilling to or unable to specify exactly these locations. Rather than permitting coders to randomly assign address codes (at the data zones level of detail), they were instructed to pinpoint the district or municipality in the Planning Area where possible. It is our practice to handle this problem in the manner described below, using a special 1107 computer program.

It was the purpose of the Zonal Code Distribution Program to assign precise address codes (at the data zone level of detail) by a mathematical (Monte Carlo) Assignment Technique. The codes were assigned to a traffic zone in the designated district, or municipality, according to the employment opportunities enumerated in each traffic zone. This work was completed during December 1964.

4. Sort of Master File

An important program for the 1107 System was the Sort-Merge Program. This program sorted in order, household or trip records by zone, sample, person

and trip number. The file could, of course, be sorted by this program in order on any other field of the data file. This operation was completed during November 1964.

5. Summary of Survey Data

For analysis work during 1964, three special summary programs were written during November, 1964. It is our standard practice that the summary of data be accomplished by such computer programs. Details of the programs and their summary outputs are described below:

(i) Summary Program No. 1

This program summarized the basic data of the survey data file, which was sorted previously by home zone number, sample number, etc. The following data was summarized on a home zone basis:

- Population
- Population 5 years of age and older
- Number of dwelling units
- Number of passenger cars
- Average worker income

General trip data was also summarized by this program. This information consisted of trip summaries categorized by specified trip purposes and by trip start time in half hour intervals over the day. Further, summaries were prepared on frequency of travel versus trip length for specified trip purposes and travel modes for the following time periods:

i. e. AM 2 hour peak, PM 2 hour peak, All day.

(ii) Summary Program No. 2

This program summarized the data file once sorted by origin zone and/or destination. For each origin (or destination) zone the number of trips by specified trip purposes was summarized.

(iii) Summary Program No. 3

The program was primarily intended to extract the information from the data file that would be required for investigation of where and how people travel. For selected origin and destination interchanges the

number of expanded trips by the following trip purpose was tabulated:

- Home to Work
- Home to Business, Commercial, Social, Recreation
- Home to School

In addition, the following data was also tabulated for each study zone interchange and for each of the above trip purpose categories for special time periods:

- Total automobile person trips
- Total auto drivers who need a car to do one's work
- Total transit trips
- Total railway trips
- Total transit trips made by people with no driver's licence or no cars owned
- Average door-to-door time by transit
- Average number of transfers by transit
- Average number of riders by auto

Lastly, for each origin and destination interchange the following data was tabulated:

- Average walking time by transit
- Average walking time by auto
- Average parking cost
- Frequency of parking by: free, street meter, pay.

The application of these summary data to investigate why, when, where and how people travel is described in Chapter on Travel Trends.



APPENDIX B

APPENDIX B

ON SAMPLE CHECK OF THE CODING FOR THE RESULTS OF THE TRAFFIC SURVEY CONDUCTED BY TRC FOR THE METROPOLITAN TORONTO PLANNING BOARD

(Prepared for Traffic Research Corporation Limited by B. A. Griffith
of J. Kates and Associates)

1. Introduction

The reader will note that although the coding checks were carried out on data obtained over the Metropolitan Toronto Region the information of specific interest in this report is contained in Lots 1 and 2 below.

The coded questionnaires resulting from the survey were considered in seven (7) lots, each lot corresponding to a well-defined area in the region covered by the survey. The seven areas so defined comprise the whole survey region. The numbers of questionnaires in the lots and the areas represented are tabulated below.

<u>Lot</u>	<u>Number of Questionnaires</u>	<u>Area Represented</u>
1	13,391	Metropolitan Planning Area
2	1,450	<u>The Fringe of the Planning Area</u>
3	2,490	Hamilton and Hamilton Area
4	1,181	Oakville - Burlington
5	2,240	Guelph and Guelph Area
6	1,429	Barrie and Barrie Area
7	1,571	Oshawa - Bowmanville

Four batches of 49 or 50 questionnaires each were selected from each lot.

The selection procedure for any batch can be illustrated by an example. Thus, to select a single batch from Lot 1, we divide 13,391 by 50 and round the result to the integer just below the result; we get the answer 267. A random number in the

range 1 to 267 was then chosen. The 13,391 questionnaires were sequenced and the first selection was the questionnaire with serial number equal to the random number chosen. Thereafter, every 267'th questionnaire was chosen until the batch was complete. Thus the members of each batch were distributed uniformly over the questionnaires in the lot and all the questionnaires in the lot had essentially the same chance of being selected.

The codes recorded on the selected questionnaires were carefully checked and all errors recorded for the four batches in each lot for Home Zone Codes and for at least two batches from each lot in the case of the other codes.

The results are shown in the attached table.

2. Analysis of Results

For each of the five (5) types of codes:

- Home Zone Codes
- Non-Home Zone Codes
- Occupation Codes
- Industrial Codes
- Property Codes

a sample error rate by batch was calculated. From these error rates by batch, error rates by lot (or area) and in total were calculated.

Statistical procedures were then applied to check:

- (a) The consistency of error rates between batches from the same lot (or area).
- (b) The consistency of error rates among lots.

The results of this analysis are discussed below:

Home Zone Codes

For home zone codes, the error rate is uniformly low over all batches and in all areas. Out of a total of 1,396 home zone codes checked in the complete sample, only 6 were found to be in error. This corresponds to an average sample error rate of 0.43 percent. On this basis, it is calculated that, in the complete survey, there is less than one chance in twenty that the error rate for home zone codes is as high as 0.83 percent. The true error rate for home zone codes applicable to the whole survey is almost certainly less than this upper limit; the most probable value for this error rate is 0.43 percent and there is better than an even chance that its value is less than 0.5 percent.

Non-Home Zone Codes

The average error rate for the complete sample was found to be 3.3 percent for non-home zone codes. This is considerably higher than for any of the other codes. Moreover, there is some evidence that the error rate for this type of coding varies somewhat from area to area. If the batches corresponding to the several areas were all taken from a common source having a 3.3 percent error rate, we can calculate limits R_1 and R_2 ($R_1 < R_2$), between which the observed error rate for any area should lie in 19 out of 20 trials. The observed error rate for area 1 (1.9 percent) is less than R_1 , while that for area 2 (4.5 percent) is only slightly less than R_2 . Thus there is some evidence to support the view that the true error rate in area 1 is definitely lower, while that in area 2 is higher than in the other areas.

Area 1 is, for the most part, a well settled area for which up-to-date maps and manuals are available; area 2, on the other hand, is one in which rapid growth is taking place and for which maps and manuals may be somewhat inaccurate. This fact alone may be responsible for most of the difference observed in the error rates for these two areas.

For each of the seven (7) areas, we have reported error rates for two distinct batches. The observed error rates for the two batches from the same area do not agree; however, the difference between them is, with the exception of area 5, well within the limits calculated for two batches drawn at random from a common source. For area 5, the two error rates are 5.2 percent for one batch and 1.5 percent for the other. For two samples drawn from a common source, error rates differing by this amount or more could be expected to occur less frequently than once in twenty trials. Too much importance should not be attached to the fact that one such large difference occurred among the seven (7) independent pairs that were examined.

In view of the fact that the error rate may have varied somewhat from area to area, a weighted average error rate is to be preferred to a simple arithmetic average. Since area 1, with the lowest observed error rate, contributes over half the total number of questionnaires, it is clear that the expected error rate for the whole survey will be less than the average sample rate of 3.3 percent. When the error rate in each area is weighted in proportion to the number of survey questionnaires from that area, a weighted average error rate of approximately 2.6 percent is obtained. This result has been obtained as a result of checking nearly 5,000

individual non-home zone codes. It is extremely unlikely, therefore, that an error rate of as much as 3 percent remains in the survey coding pertaining to non-home zone codes.

Occupation, Industrial and Property Codes

For the most part, error rates for occupation, industrial and property codes are uniformly low over all areas. The most notable exceptions appear to be occupation codes in area 3 and property codes in area 2. Occupational coding for area 3 was done locally using abbreviated manuals; property coding in area 2 presented a few unusual problems.

The average error rates over the complete sample are 1.2 percent for occupation codes, 0.7 percent for industrial codes, and 0.9 percent for property codes. In view of these low average error rates and the partial explanation of the two higher than average rates, it would appear that the accuracy achieved in these codes is quite satisfactory.

3. Conclusions

The sample check of the coding for the 1964 Traffic Survey appears to have been carefully and correctly conducted. The results indicate a very low error rate in home zone codes and quite low error rates for occupation, industrial and property codes. For non-home zone codes, the error rate is considerably higher than for the other codes. A weighted average of the results indicates an error rate of about 2.6 percent in the total data for non-home zone codes.

In view of the inevitable uncertainty that attaches to surveys of this kind and the application of the results to traffic forecasting and also due to the fact that such coding errors as do remain can be expected to partially compensate one another, it would seem difficult to justify the expense of further checks.

TABLE OF RESULTS

Lot or Area	Home Zone Codes - Errors			Non-Home Zone Codes - Errors			Occupation Codes - Errors			Industrial Codes - Errors			Property Codes - Errors		
	Batch	No. of Codes	No. %	Batch	No. of Codes	No. %	Batch	No. of Codes	No. %	Batch	No. of Codes	No. %	Batch	No. of Codes	No. %
1	1-4	200	1 0.5	1 2 1,2	360 313 673	4 9 13 1.1 2.9 1.9	1 2 1,2	168 168 336	0 1 1 0 0.6 0.3	1 2 1,2	168 168 336	0 2 2 0 1.2 0.6	1 2 1,2	304 275 579	0 0 0
2	1-4	197	2 1.0	3 4 3,4	480 335 815	25 12 37 5.2 3.6 4.5	3 4 3,4	191 192 383	3 0 3 1.6 0 0.8	3 4 3,4	191 192 383	2 1 3 1.0 0.5 0.8	3 4 3,4	311 290 601	10 3 13 3.2 1.0 2.2
3	1-4	200	1 0.5	1 2 1,2	230 278 508	8 10 18 3.5 3.6 3.5	1 2 1,2	171 160 331	5 5 10 2.9 3.1 3.0	1 2 1,2	171 160 331	0 3 3 0 1.9 0.9	1 2 1,2	211 244 455	4 1 5 1.9 0.4 1.1
4	1-4	200	2 1.0	1 2 1,2	385 391 776	16 8 24 4.2 2.0 3.1	1 2 1,2	192 173 365	0 1 1 0 0.6 0.3	1 2 1,2	192 173 365	1 2 3 0.5 1.2 0.8	1 2 1,2	334 330 664	5 4 9 1.5 1.2 1.4
5	1-4	199	0 0	2 4 2,4	392 390 782	22 6 28 5.6 1.5 3.6	2 4 2,4	176 155 331	1 4 5 0.6 2.6 1.5	2 4 2,4	176 155 331	1 0 1 0.6 0 0.3	2 4 2,4	234 348 582	0 3 3 0 0.9 0.5
6	1-4	200	0 0	2 4 2,4	341 316 657	16 8 24 4.7 2.5 3.7	2 4 2,4	163 167 330	1 2 3 0.6 1.2 0.9	2 4 2,4	163 167 330	1 3 4 0.6 1.8 1.2	2 4 2,4	295 278 573	1 4 5 0.3 1.4 0.9
7	1-4	200	0 0	2 4 2,4	313 281 594	13 6 19 4.2 2.1 3.2	2 4 2,4	152 161 313	5 1 6 3.3 0.6 1.9	2 4 2,4	152 161 313	0 1 1 0 0.6 0.3	2 4 2,4	272 253 525	1 1 2 0.4 0.4 0.4



APPENDIX C

APPENDIX C

METROPOLITAN TORONTO PLANNING BOARD DATA BANK

1. Introduction

It is the purpose of this section to describe the establishment of the MTPB Data Bank. This Data Bank comprises a "computer" oriented reference library of land use and transportation statistics which are considered useful in transportation studies. The Bank is designed to permit the rapid filing of data, convenient updating of data already "banked", the combination of data by different geographical units or zones and the retrieval and tabulation of stored information.

The design of the Data Bank permits the storage of many categories of data, considered essential in transportation studies. The Bank is expandable and contractable in the types of data which can be stored.

2. Data Categories

Several classes of data should be considered for incorporation into the Data Bank. In summary, these classes are the following:

(a) Community Characteristics

1. Dwelling Units
2. Population
3. Employment
4. Number of cars
5. Acreage of land use activities and/or densities of development.
6. Household income, wages and salaries

(b) Travel Demand

1. Person trip summaries by data zone
2. Origin-destination trip summaries
3. Traffic volumes on roads, TTC and commuter railroad traffic

(c) Transportation Facilities

1. Road capacity and physical description
2. Road speeds and travel times
3. Characteristics of urban transit service
4. Characteristics of intercity bus service
5. Characteristics of rail service
6. Parking inventory

In order to "Bank" these data it is necessary to assign geographical identification.

3. Geographic Identification

Nearly all of the statistics mentioned have some geographic association whether it is pertinent to a certain point (e. g. intersection), a line (e. g. highway) or area (e. g. zone). Thus it is convenient to have some sort of reference coordinate system to identify points, or delineate lines and perimeters of areas. This would make it possible to find rapidly the location to which any statistic pertains. Since each group of municipalities has a particular orientation of its road grid it may be more convenient to use several coordinate systems tied together by reference points. Consideration must be given to the most convenient form for

storage, data processing and presentation.

If the Planning Area is subdivided into a fine set of geographic zones and a detailed pattern of links in its transportation grid, then the problem of incompatibility in future zoning systems for transportation studies would be minimized. Any future study could select its zones in some area as simple units of the Planning Area subdivision and could aggregate their subdivisions into larger zones where detail is not necessary. Data Bank statistics should pertain to the smallest possible link or zone where possible unless it becomes impractical or inaccurate to collect statistics in such detail.

4. General Purpose Computer Program System

A system of computer programs was written which permits the following operations in connection with the Data Bank.*

- Updating
- Adding information to record
- Aggregate small geographical units into large units
- Performs calculations such as densities, ratios and trends, etc.

A brief description of these Data Bank Programs is presented below:

* The program system was written under contract with the Metropolitan Toronto and Region Transportation Study by Traffic Research Corporation Limited, 1964. This work was in accordance with Contract No. 1 between M. T. A. R. T. S. and TRC, March, 1964.

1. Data Stacking Block-DASTAK

DASTAK accepts raw data input punched on cards according to a standard format. It creates a tape which contains this data and which can be efficiently read by other Data Bank Programs. Recall that the initial function of the Data Bank is to accept separately data from incompatible sources. DASTAK accepts decks of cards, passes them on in tape form to other Data Bank Programs for modification to a standard of compatibility, and then accepts pairs of modified compatible tapes for merging into one uniform data bank.

2. Data Modification Block-DAMOD

If by chance an erroneous value was specified for a variable category for a certain data zone and was loaded onto tape by DASTAK, it can be corrected while on tape by DAMOD by the insertion of a single new value.

3. Data Update Block-SUSTAK

This program adds new tracts or data zones with their corresponding data to an existing Data Bank file.

4. Town Aggregation Block-AGTWN

In some cases data are available only on the basis of data zones. Alternatively, we may wish to test the performance of the Traffic Model if the Metropolitan Toronto Planning Area is divided into 100 rather than 500 data zones. AGTWN aggregates the data on a geographical basis.

5. Data Combination Block (Combined Variable Block)-COMVAR

COMVAR is the nerve centre of the Data Bank. It uses any combination of the arithmetic processes to aggregate or generate variable categories from

the raw data. Each process specified is repeated identically for everyone of the data zones. Initially, COMVAR is used to alter incompatible categories or generate missing ones. Later, the analyst specifies which variables are to be combined, and COMVAR is now used to generate the significant "super" - variables which form the structure of the planning work, i. e. density, ratios, etc.

6. Data Difference Block-DIFF

To obtain trends of variable categories, the values of corresponding categories of the historical year must be subtracted from those of the current year. DIFF subtracts data on two tapes (one for each year) and writes a third difference tape. As an extra merge feature, it can also add two tapes and create a third sum tape.

5. Data Categories in Bank

The following data items have been summarized by data zones (census tracts in the Corporation Area and traffic zones in the remainder of the Planning Area) and are stored in the MTPB Planning Area Data Bank.

(a) Community Characteristics

1. Dwelling Units
2. Population and population 5 years of age and older
3. Number of cars owned and garaged at home
4. Average worker income (household income divided by number of workers)
5. Employment by nine categories:
 - primary
 - manufacturing

- construction
- transportation, storage and communication
- wholesale trade
- retail trade
- finance, insurance, real estate
- recreation and person service
- other services

(b) Travel Demand

1. Person trip summaries by data zone for the AM peak (7-9 AM), PM peak (4-6 PM) and off peak (remaining 20 hours) periods for each of the following trip purposes:

- 1.1 Trip Departures (trip starts)

- from home to all purposes and vice versa
- from home to work and vice versa
- from home to personal business and others and vice versa
- from home to shopping and vice versa
- from home to school and vice versa
- from home to social and recreation and vice versa
- from all purposes except home to all purposes except home

- 1.2 Trip Arrivals (trip ends)

- at all purposes from home and vice versa
- at work from home and vice versa
- at personal business and others from home and vice versa
- at shopping from home and vice versa
- at school from home and vice versa
- at social and recreation from home and vice versa
- at all purposes except home from all purposes except home

2. Origin-destination summaries (see Appendix A, Section 5) of person trips by mode.

6. Data Categories Recommended for Banking

The following data categories are available or could be assimilated and are deemed suitable for incorporation in the Data Bank.

(a) Community Characteristics

1. Miscellaneous household and population characteristics (see suggested list prepared by Mr. Hans Blumenfeld, February 11, 1965 on "Cross-Tabulation of Household Reports 1 and 2. ")
2. Land Use Statistics, i. e. acreage by each classification of land use.
3. Data Summaries of the Metropolitan Toronto Assessment Department.

(b) Travel Demand

1. Miscellaneous zonal summaries of person traffic and origin-destination summaries (see suggested list prepared on "Cross-Tabulation of Trips Report 3 and 4".)

(c) Transportation Facilities

1. MTPB Road and Transit Inventories
2. MTPB Parking Inventory

Note: Special Summary purpose programs such as those described in Appendix A Section 5 must be prepared. These programs will be necessary to summarize detailed data for (a) and (b) above by suitable geographical units or data zones. Once the data is summarized by data zones it can be easily banked.

FORM SB-OS-35
2M-65-645

DEPARTMENT OF HIGHWAYS ONTARIO

FILE No. _____

REMARKS _____

DATE _____

